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PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' CLUB.

VOLUME I.

LONDON:

PRINTED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET.

1853.

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CONTENTS OF VOL. I.

	Page
Address to the Cotteswold Naturalists' Club, read at Gloucester, January 18, 1849. By T. B. LLOYD BAKER, Esq., President.....	1
On the Poison Gland in the Jaw of <i>Geophilus longicornis</i> . By THOMAS P. WRIGHT, Esq., M.D. &c.	9
A few general Remarks on the Fossil Conchology of the Great Oolite of Minchinhampton in comparison with that of the same Formation in other localities. By JOHN LYCETT, Esq.	11
Notes on the distribution of the Fossil Conchology of the Oolitic Formations in the vicinity of Minchinhampton, Gloucestershire. By JOHN LYCETT, Esq.	17
Address to the Cotteswold Naturalists' Club, Read at the Winter Meeting, January 22, 1850. By Sir THOMAS TANCRED, Bart.	29
Heights of some points of the Cotswold Hills, with some experiments with the Aneroid Barometer. By W. HENRY HYETT, Esq., F.R.S.	38
On <i>Trichites</i> , a fossil genus of Bivalve Mollusks. By JOHN LYCETT, Esq.	42
On the Structure and Arrangement of the Tesserae in a Roman pavement discovered at Cirencester in August 1849. By JAMES BUCKMAN, F.L.S., F.G.S.	47
Sketch of the Geology of the neighbourhood of Grantham, Lincolnshire; and a comparison of the Stonesfield Slate at Collyweston in Northamptonshire with that in the Cotswold Hills. By the Rev. P. B. BRODIE, M.A., F.G.S.	52
Tabular View of Fossil Shells from the middle division of the Inferior Oolite in Gloucestershire. By JOHN LYCETT, Esq.	62
A Stratigraphical Account of the Section from Round Tower Point to Alum Bay, on the North-west coast of the Isle of Wight. By THOMAS WRIGHT, M.D.	87
Address to the Cotteswold Naturalists' Club, read at Bristol, Feb. 10, 1852. By T. B. LLOYD BAKER, Esq., President	101
Contributions to the Palæontology of Gloucestershire:—On the	

	Page
<i>Strombidæ</i> of the Oolites. By THOMAS WRIGHT, M.D. With the description of a new and remarkable <i>Pteroceras</i> . By JOHN LYCETT, Esq.	115
A Stratigraphical Account of the Section of Hordwell, Beacon, and Barton Cliffs, on the coast of Hampshire. By THOMAS WRIGHT, M.D. &c.	120
On the <i>Cidaridæ</i> of the Oolites, with a description of some new species of that family. By THOMAS WRIGHT, M.D. &c.	134
On the <i>Cassidulidæ</i> of the Oolites, with descriptions of some new species of that family. By THOMAS WRIGHT, M.D. &c.	174
Contributions to the Palæontology of the Isle of Wight. By THOMAS WRIGHT, M.D. &c.	229
Note on the <i>Gryphæa</i> of the Bed called Gryphite Grit in the Cotteswolds. By JOHN LYCETT, Esq.	235
Additional Notice of the genus <i>Tancredia</i> (Lycett), <i>Hettangia</i> (Turquem). By JOHN LYCETT, Esq.	237
Remarks on the Lias at Fretherne near Newnham, and Purton near Sharpness; with an Account of some new Foraminifera discovered there; and on certain Pleistocene Deposits in the Vale of Gloucester. By the Rev. P. B. BRODIE, M.A., F.G.S.	241
On some new species of <i>Trigonia</i> from the Inferior Oolite of the Cotteswolds, with preliminary Remarks upon that Genus. By JOHN LYCETT, Esq.	247
On the Cornbrash of the neighbourhood of Cirencester. By JAMES BUCKMAN, F.L.S., F.G.S., Professor of Geology Royal Agricultural College	262
Remarks on <i>Libellula Brodiei</i> (Buckman), a Fossil Insect from the Upper Lias of Dumbleton, Gloucestershire. By Professor BUCKMAN, F.G.S., F.L.S.	268
APPENDIX. Address to the Cotteswold Naturalists' Club, read at Cheltenham, at the Winter Meeting of 1851. By T. B. LLOYD BAKER, Esq., President	i-xiii

*Report of the proceedings at the First Meeting for 1847 of the
Cotteswolds Naturalists' Club.—From the Wilts and Gloucestershire
Standard.*

THE first meeting of the season was held last Tuesday (April 13th) in our town. After breakfasting at the Ram Inn the Members of the Club visited the Roman pavement at the Barton, and the Royal Agricultural College, where numerous workmen are busily employed on the chapel, theatre, and farm buildings. The unfavourable state of the weather rendered it necessary to limit the excursion to the railway cuttings in Hailey Wood, instead of proceeding to Sapperton. The woods are now decorated with a profusion of blue scentless violets (*Viola hirta*, Lin.), primroses, and wood anemones, but many of the more interesting of our native plants, such as the parasitical tooth-wort (*Lathræa squamaria*, Lin.), are a month later in their flowering than last year. To the botanist who looks after the more minute productions of Nature, a profusion of mosses are spread over the stone walls in various stages of fructification. After their walk the club returned to an excellent dinner at the Ram Inn. Amongst the company present were Dr. Daubeny, of Oxford, in the chair; the Rev. W. F. Powell, the Rev. J. M. Prower, the Rev. — Mason, Rev. — Daubeny of Eastington, jun., D. Bowly, Esq., E. Bowly, Esq., Sir Thomas Tancred, Mr. Gyde, of Painswick, Thomas Warner, Esq., C. Pooley, Esq., S. Lediard, Esq., Professor Woodward, R.A.C., &c., &c.

After dinner Dr. Daubeny read a letter from a gentleman at the Cape, by which it appeared that the potato disease might be expected ultimately to wear out, by analogy with what had there occurred to the sweet chesnut.

Mr. Woodward called attention to a report in the *Morning Chronicle* of a meeting of the Botanical Society of London, from which it appeared that every scientific man, in or out of England, repudiated the speculation of Mr. Smee, that the disease was caused by, or in any way connected with, the turnip plantlouse (*Aphis Rapa*, Curtis).

Mr. Charles Pooley next read a letter from a friend at Smyrna, on the state of agriculture in that part of Asia Minor. Possessing a wide extent of fertile alluvial soil, and a delightful climate, in which the olive and vine, and most of the cereals—wheat, barley, rye, oats, and maize, may be successfully cultivated, the mode of farming is slovenly, and extremely primitive in its character. Draining, though requisite, is unknown; manure only used for the

vineyards; regular rotations unheard of; potato only cultivated for the European residents; and the land is held conditionally on the payment of one-half the produce.

Sir Thomas Tancred exhibited to the meeting a collection of insects, presented to the Agricultural College by P. J. Selby, Esq., of Twizell House, Northumberland. The collection consists of 372 named species of beetles, and 13 species of moths, including many of those which are most injurious to farming.

The next communication was made by Mr. Woodward, at the request of Sir Thomas Tancred—"On the Geology of the district explored by the Cotteswolds Club, and more particularly the Clay subsoil of the College Farm." On account of the local interest attaching to this paper, we insert it at full length—

"The Cotteswold hills form an elevated tract nearly in the centre of England, which extends in a N.E. and S.W. direction through the county of Gloucester, from Campden to Wootton-under-Edge, a distance of 30 miles, and occupies an average breadth of 10 miles.

"The surface of this district has a general inclination to the S.E., its eastern borders having an elevation of about 400 to 500 feet above the sea; whilst the Western ranges from 600 to 800 feet, and the culminating point, Cleeve Cloud, is 1134 feet high,

The Thames and Severn canal passing through the centre of the district, affords an excellent *datum line*, for estimating the elevations of various points; from Siddington to Sapperton it preserves the same level, but beyond each of these points numerous locks indicate a rapid fall of the general level of the country towards Swindon, and of the valley towards Stroud and Gloucester. The branch of the Great Western Railway from Swindon to Gloucester passing through the same line of country, has given the key of its geological structure.

"The Hills are entirely composed of two strata of Oolitic limestone, separated by a bed of clay known to geologists as the "Fuller's Earth." These strata are inclined to the S.E., at the rate of about 1 in 130, or less than half a degree; yet this inclination is greater than that of the general surface, and sufficient to carry the hill strata beneath formations of later date on the S.E., whilst on the N.W. boundary they terminate in steep escarpments, broken and indented by numerous deep and picturesque valleys, which pursue a winding course among the hills. Such are the valleys of the Coln at Withington, and the "Golden Valley" of Sapperton. During the winter, small streams wander through these western valleys to the Severn; in summer many of the springs fail, and the streams are concealed by reeds and rushes; for owing to the *inclination of the strata*, almost all the rain which falls on the Cotteswolds supplies streams which flow in an opposite direction. The Severn Wells, near Cubberly, and the Thames Head both supply tributaries of the Isis.

The water in these streams and in neighbouring wells is prevented from sinking to a lower level by beds of marl or clay, which, when removed from atmospheric influence, are impervious to water; above

these clays all the joints and fissures of the rocks are filled with water up to a certain level, varying with the quantity of rain which falls at different periods of the year.

Mr. T. C. Brown observed that in the fissure which supplied the first gush of water to his well at Further Barton, there were indications of a considerable current at the depth of 100 feet, afforded by the sand polished surfaces of the rock.

"But the Cotteswolds Club does not confine its wanderings to the hills; our district legitimately extends to the Severn on one side and to the Chalk Downs of Wiltshire on the other. From the tower of the Agricultural College we can look over a wide extent of undulating country, bounded in the distance by the blue hills of Wiltshire, and presenting in the middle distance a lower range extending from Faringdon Clump to Derry Hill. We are on the S.E. boundary of the Cotteswold Hills, and the country before us exhibits a different geological and agricultural character. It is watered by numerous streams, and presents an infinite variety of soil and culture; oak woods and elms succeed the interminable beech woods of the hills, and pasture and water meadows are frequent."

In order to obtain a general idea of the nature and succession of the subsoils (or *strata*) of the whole district, we may conveniently pursue the "Ermine Way," which coming from Newbury through the Wanborough Downs, runs almost in one straight line to Cricklade, Cirencester, Birdlip, and Gloucester, passing over in succession the whole of the Oolitic strata in the following order:—

- 1.—Portland stone.
- 2.—Kimmeridge clay.
- 3.—Coral rag.
- 4.—Oxford clay.
- Kelloway rock.
- 5.—Great Oolite: subdivided into
 - Corn brash.
 - Forest marble.
 - Bradford clay.
 - Bath freestone.
 - Stonesfield slate.
- 6.—Fuller's earth.
- 7.—Inferior Oolite.
- 8.—Lias.

1.—The *Portland Stone* is seen best in the quarries near Swindon Old Town: it is the only stratum in the series which appears to have been partly formed on dry land, or in fresh water; the rest are entirely of marine origin.

2.—The *Kimmeridge Clay* occupies the valley in which Swindon station and New Town are situated.

3.—The *Coral Rag* rises up from beneath the clay, and forms the hills about Stratton Saint Margaret's, Pen Hill, and Blunsdon.

4.—The *Oxford Clay* occupies the whole of Braydon Forest, and the wide valley around Cricklade, but is often covered by thick beds

of Oolitic gravel. At Foss Farm, Driffild, is a hill of sand covered with furze, which Mr. Bravender has pointed out to me as representing the *Kelloway Rock*, and from which he has obtained a specimen of *Ammonites Herveyi*.

5.—At Driffild cross-ways we may see the *Corn Brash* in the small quarries from which the road stone is obtained, and in descending the hill towards Cirencester we pass over to the *Forest Marble*, a thin-bedded stone, well shewn in the quarries at Preston, from which much of the roofing stone and planking so extensively used in the neighbourhood are obtained. Frequent beds of marly-clay alternate with the stone, one of which, on Mr. E. Bowly's Farm, at Siddington, is worked as a brick-field. One of these beds of clay is usually found dividing the Forest marble from the Bath freestone, and consequently represents the *Bradford Clay*. Beyond Stratton our road lies over the Bath freestone (or "Hampton stone") as far as Highgate, where several deep valleys expose the *Stonesfield Slate*, *Fuller's Earth*, and *Inferior Oolite*.

The quarries near Birdlip also exhibit the Inferior Oolite, and the remainder of the road to Gloucester rests upon the *Lias*.

If an Artesian well (such as that now in progress at Southampton) were attempted at Swindon New Town, it would pass through all the above-mentioned strata, from the Kimmeridge clay to the Lias, in the *same order* in which they are passed over by the Ermine way, reaching the surface of the Lias at a depth of about 1000 feet.

The same system of strata forms a continuous tract of country, having similar characters, extending from Scarborough and Whitby, on the Yorkshire coast, to Lyme Regis and the Isle of Portland, on the coast of Dorsetshire.

Having said thus much on the Cotteswolds district, I will refer now more particularly to the subsoils of the College Farm.

When I first visited Cirencester in August, 1845, I obtained from Mr. Bravender an account of the neighbouring rocks and quarries, more particular than was afforded by any published document; for the geological maps represent by one colour all the country between the Oxford clay and Inferior Oolite, although in the interval there are *four strata* containing different suites of fossils, and presenting an entirely different geological and agricultural character.

On a small part of the College Farm the Bath freestone forms the subsoil, and in the deepest hollow is a deposit of Oolitic gravel; but in almost every field the subsoil consists of clay and "stone brash" intermingled, for not only do the beds of clay alternate with layers of stone, but the *same bed* is at one place entirely composed of stone, and within a few yards the stone may thin out and give place to clay. "Stone brash" is the local name for rubbly limestone; even the most solid beds become "brashy" near the surface, owing to the action of frost and rain water. The stone brash of the College Farm becomes hard and "planky" at a small distance from the surface, like the Forest marble of the Preston quarries, and is part of the same formation. Hundreds of tons of this stone have been raised for

roofing the new buildings. At the depth of from 5 to 10 feet the Forest marble has usually a deep indigo tint, but nearer the surface it becomes rust-coloured. In some of the thick beds, used for pitching the streets, every stone is blue in the centre and yellow on the outside; the change is sudden and well marked, and is evidently due (as stated by Mr. Way) to the conversion of a silicate of the prot-oxyde of iron into per-oxyde, for all our stone contains a small quantity of iron, which rusts on exposure to the air or rain-water. The circumstance is of some interest, as it indicates the depth to which rain-water carries down oxygen into the subsoil; in the large joints and fissures of the rock the rust colour is strongest, and extends to the greatest depth.

The clay of the Forest marble is so variable in position, thickness, and composition, that persons accustomed only to other clay soils, would not be justified in predicating a single fact respecting it from a casual inspection of the surface. I shall therefore cite the information of those who have had most experience in the matter. The surface soil has a cold gray or chocolate hue, which distinguishes it at once from the warmer complexion of the corn-brash, and the lighter tint of the Bath freestone. The clay itself (or rather *marl*, for it always contains lime, and sometimes in large proportion) is sometimes bluish gray, and elsewhere (especially the lowest beds or Bradford clay) of a light olive tint; as, for example, in the drains which are now making near the entrance of the Park.

Mr. T. C. Brown says this clay is much benefitted by subsoiling, but not by deep ploughing—it should never be brought up to the surface; and Mr. Bravender, in his Essay on Breaking up Grass Lands, observes, that soils resting on this clay should be deepened *very gradually*; it should be done before the winter, so that it may be exposed to the full action of the frosts, and requires to be plentifully manured. Otherwise, an attempt to deepen the soil, even to the extent of *two inches*, will injure the succeeding crops for several years.

Mr. Arkell, whose management of this clay it is unnecessary for me to eulogise, has pointed out to me that it differs from the Oxford and other clays of the district, in the readiness with which it falls to pieces with frost and rain, becoming light and hollow, so as to require rolling and pressing to prevent the wheat plants from being “thrown out” by the repeated falling away of the soil. Like other clay soils it is not so well adapted for turnips or barley as for wheat and oats, vetches and broad clover. Various parts of the farm on the mixed clay and brashy subsoil are cultivated on the three-fields, and four or eight-field systems, whilst the fields with a subsoil of dry stone are kept under the five-field, or “Cotteswolds hill” system. Most of the Forest marble district requires *draining*, because even when the beds of clay are thin and interstratified with stone, they will arrest the percolation of the rain-water for a considerable time. The drains which Mr. Arkell has put in are from 3 to 4½ feet deep, and from 24 to 40 feet apart, according to the depth of the clay, and the presence or absence of stone. When the stone

is within a yard of the surface, it is less expensive to make the drains shallow and more numerous. The drains are made with the stone taken out in digging them, for which it is well adapted; in filling in the drains these stones are first placed in a triangular form at the bottom, and loose stones filled in above.

The weeds which infest the clay lands of the Forest marble district are the—

Carnation-grass, *Carex Glaucia*, Scop.

Couch, *Agrostis stolonifera*, LIN.

Black-bents, *Alopecurus agrestis*, LIN.

Garlic, *Allium vineale*, LIN.

Colts'-foot, *Tussilago Farfara*, LIN.

Red Eye-bright, *Euphrasia Odontites*, LIN.,

and others which are more ornamental than injurious, such as the

Blue Pimpernel, *Anagallis cœrulea*,

Toad-flax, *Linaria Elatine and spuria*,

and the somewhat rare *Campanula hybrida*, LIN.

Bromus pinnatus, BEAUV., infests all the pastures and borders of fields on Stone-brash and marl alike, and is readily recognised by the broad bright green leaves, which neither sheep nor cattle touch. Turfs of hair-grass (*Aira cœspitosa*), or, as they are called "Bull-peats," are also frequent in woods, meadows, and pastures, on a strong soil.

My own observations have been directed chiefly to the geological history of these formations, and especially to the fossil remains which they contain. On the present occasion I shall only notice those of the clay; they are found, I believe, almost exclusively in that particular bed which represents the Bradford clay of Wiltshire, and may be seen in the railway banks at Kemble, and the Ackman Street (Tetbury Road) station, in Mr. Gregory's grounds near the Mount, at Smerrill Quarry, and on the College Farm.

Bradford has long been celebrated for its fossils, especially the Pear Encrinite (*Apicrinus Parkinsoni*, BRONN.) an animal belonging to a group almost unknown in our seas; it was a star-fish having ten feathery arms, and supported on a long flexible stem attached to the bottom of the sea. The remains of this plant-like animal consist of fragments and single joints of the stalk and body, called "coach-wheels" by the quarrymen, the pear-shaped bodies, and detached joints of the arms and fingers. The first and most perfect specimen found near Cirencester, was obtained by the policeman at the Tetbury Road Station, and given to the College: several specimens have been obtained by Mr. Götz, a student of the College, at the limekiln quarry in Perry Moor; other specimens in the College collection were found by my brother at the Ackman Street Station, one of them is a very young encrinite, germinating on a fragment of fossil bone.

Several other characteristic fossils were obtained a few years ago by Mr. T. C. Brown and Mr. Bravender, such as *Terebratula digona* and *decussata*, *Avicula costata*, and several corals which are common at Bradford. With the assistance of my class I have obtained evidence of more than 100 species of marine animals having

inhabited the sea-bottom (where now stands the Agricultural College) at the period this clay was accumulated.

The nature of these fossils will be seen by the following list:—

<i>Plants</i> , number of species	2
<i>Sponges</i>	1
<i>Radiate animals</i> ,	
Corals, about	14
Crinoid star-fishes	3
Star-fishes	1
Sea-urchins, about	10
	— 28
<i>Articulate animals</i> ,	
Anellides, about	7
Crustaceans	1
	— 8
<i>Molluscos animals</i> ,	
Bivalves	23
Terebratulæ	10
Spiral univalves	8
Ammonites (fragment)	1
	— 42
<i>Vertebrate animals</i> ,	
Fishes, about	19
Reptiles	7
	— 26
Total	107

The *vegetable remains* consist of drift wood, as hard and brittle as coal, and a single small *Nullipore*, the only genus of marine plants capable of living at a depth exceeding 30 fathoms.

The *sponge* is a minute species, belonging to a group having a calcareous skeleton.

The *corals* are small species, such as are found in deep water; the only large reef-building species belongs rather to the Great Oolite, and covered in some places the bed of the sea upon which the animal of the Bradford clay period lived.

The *Crinoids* include a species of *Comatula*, one of which still inhabits our coasts, being attached to sea-weed in its young state, and becoming afterwards detached, and capable of swimming about in the sea.

The *Anellides* are marine worms, forming shelly tubes in which they lived; they are common upon oyster shells and corals in our own seas.

Crustacea.—Only the claws of small crab or lobster have been observed.

Bivalve shells (*Conchifera*).—Casts of several species are common; small oysters, of two or three kinds, and scallops are very common.

Ten species of Terebratulæ have been discovered, but the individuals are exceedingly numerous; these shells are eminently characteristic of deep water, even at the depth of 100 fathoms

The spiral shells are casts and minute *Corithia* and *Norinea*.

Chambered shells (*Cephalopoda*) are extremely rare in Great Oolite generally, no Belemnites have yet been found, and only one minute fragment of an ammonite.

The remains of Vertebrate animals belong exclusively to the cold-blooded classes, for although small Insectivorous and Marsupial quadrupeds had undoubtedly existed at the period of the deposition of the Stonesfield state, no teeth or remains have been detected hitherto in the Bradford clay.

The skeletons of fishes, especially the *sharks*, contain so little of the carbonate and phosphate of lime that only the harder portions of their skeletons—the teeth and enamelled scales are usually found in a fossil state. The College collections contains numerous forms of crushing teeth, or “palates,” of extinct species allied to the Port Jackson shark, which lives upon shell fish and crustaceans; there are also sharp-pointed teeth of other *sharks*, and the mandibles of a Chimæroid fishes.—(*Ischyodus Egerton*.)

Reptiles.—I have obtained the teeth of several species of the large carnivorous saurians, (*Plesio* and *Ichthyosauri*), and there are small sculptured plates and fragments of bones, which, I believe, belong to some small marine turtle.

The collection contains also a suite of specimens from Bradford, presented by the Rev. W. Dansey, of Donhead St. Andrew, and Mr. Joshua Brown.

In conclusion, I wish to remark, that although it may answer no agricultural or other economic purpose to examine minutely into all such details as the preceding, yet it may be useful to the engineer and the farmer to possess as much knowledge of the *characteristic fossils* of the British strata, as will enable him to pronounce with certainty the geological relations of any particular stratum in which he may be more immediately interested, and it requires no unusual industry or intelligence to learn the physiognomy of a few shells, such as will serve this purpose. Whatever system of farming, and whatever practices are found beneficial on the College Farm, will be equally successful wherever the Forest-marble and Bradford clay are met with, and as a means of identifying these strata, I know of no method more simple and more certain than the examination of the fossils which are so plentifully distributed in them. Those only who have attempted to generalize the observations made in a particular district by means of geological laws, are in a position to appreciate the *usefulness* of such enquiries; but to the natural historian they have an attraction independent from question of utility; he does not look upon this deposit as so many feet of clay merely, but sees in it a historical monument of times long ere man became the tenant of the globe; when the care of Providence was bestowed as lavishly, as in our own day, upon numerous races of unreasoning creatures, until the earth was fully prepared for its last and noblest inhabitant, to whom should be given, not merely a vegetative or animal existence, but intellectual and spiritual life.

Address read to the Cotteswolds Naturalists' Club, at their Winter Meeting, held at Gloucester, January 18th, 1849. By T. BARWICK
LLOYD BAKER, Esq., of Hardwicke Court, President.

GENTLEMEN,

Three summers have now shone on the gatherings of the Cotteswolds Naturalists, and for the third time we are assembled for our winter meeting. Our Club was originally formed on the model of a similar society in Berwickshire, and, as it was there the custom that the President should each year address to the meeting a short recapitulation of the proceedings of the club, so I have readily undertaken to follow the same example, as it leads of course to the adoption of another excellent rule of the same society, by which the President is annually—changed.

However reluctant, therefore, I may be to trespass on your time and detain you from more interesting matter, I must ask you to bear with me while I go through a short recapitulation of the meetings we, or many of us, have enjoyed together; and if the looking back to past troubles is agreeable by the contrast, I trust you will not be less inclined on the retrospect of such pure and satisfactory pleasures as ours to say *Hæc olim meminisse juvabit*.

True to the original design of keeping clear of cities and the grander hostleries, and of seeking Nature in her remoter haunts—our first meeting took place on the 7th of July, 1846, at the Black Horse, at Birdlip, when the original members of the club were proposed and elected. Hitherto those who, like myself, had taken a warm interest in the idea of such a society, had almost dreaded the moment of its taking a tangible form, least we should find that it was no sooner touched than it dissolved. But when amongst the names of those who were willing to join us, we found those of Daubeney and Strickland—that the Professors of the Royal Agricultural College—together with more names connected with high talent than I will now enumerate—were at our first meeting enrolled amongst us, we began to feel a confidence in that of which we had before but a faint hope, but which has since arrived, I trust as nearly as may be at certainty—that we may go on and prosper.

But next came a difficulty—a President must be chosen. The list of members was searched for one who would be able and willing to take so eminent a situation, Dr. Daubeney was engaged in services due not more to his University than to the Nation. The Principal of the Cirencester College was carrying out an equally grand and important national benefit.

Sir Thomas Tancred, with whom had originated the idea of the formation of the Club in this County, and who promised to be and has been our main stay throughout—was willing to take the far more useful office of Secretary. Nearly all were engaged in more important matters (though some urged only modesty as their excuse), till it turned out that the only

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member who was good for nothing else was your present President, who was accordingly elected, and having failed to prove himself useful in any other capacity, has continued as your President to this day.

The business of the formation of the Club, and its few and simple rules having been most appropriately transacted in the garden of the Inn, on the summit of one of our own Cotteswold Hills, with the rich Vale of the Severn lying at our feet, and the bold chain of the Volcanic Malverns, with the old red sandstone of May Hill and the Forest of Dean in the back ground—we commenced our walk through the Beech woods of Witcomb Park—by the fine remains of the Roman Villa, with its beautiful tessellated pavements to Cooper's Hill, where our Geologists found some interesting Quarries—and all found interest in a grand and extensive view—and returned to Birdlip through the wild and forest like district of the Cranham wood.

I will say nothing of the objects of interest we met with in our course, though it was a good specimen of the north-eastern part of the Cotteswolds summits—abounding with fine views, principally up the Valley towards what is usually known as the Vale of Evesham—and full of a rich and luxuriant beauty.

But I must allude to one good omen that occurred at this our first meeting—in the presence of a Naturalist of that Society on the model of which we are formed. This is not a fit time to speak of the private merits of one of my oldest and kindest friends, but I may simply allude to the spirit which breathes through Selby's works, as a proof of the real value of that study which it is the object of our meetings to cultivate; for a really sound Naturalist can hardly be other than a good and happy man.

Ere we parted, delighted I believe universally with our first day, we had agreed at our next meeting on August 18th, to take a bolder flight, beyond in truth the limits we had originally intended as the Park of our Club; and to visit that wild district beyond the Severn, little known indeed to most Gloucestershire people who dwell on this side the water; except by its name of the Forest of Dean.

The night of August 17th found many of the party assembled at the King's Head, at Gloucester, though some, undeterred by distance, even left Cirencester on the morning of the 18th, determining to perform the whole in the day, or at least within the twenty-four hours. Our party, to the number of eight or ten, then started in a break, which Mr. Lysons had kindly lent to us, to Westbury-on-Severn—where we spent some time in examining Westbury Cliff, where the bone bed at the junction of the Lias and red marls overhanging a broad reach of the Severn, afforded objects of great interest to the Geologist, the Botanist, and the lover of Scenery—to the former indeed it was peculiarly interesting, as Mr. Woodward pointed out to us the importance of this bone bed which divides the strata throughout England into two divisions, characterized (as many of the phenomena of nature are, by objects which have no apparent reference to such a distinction) by the different types of the fish embedded in each; the lower or older strata abounding with fish having their tails unequally forked: whilst those of a shape more resembling the existing genera are found in the Lias and the superior beds.

Returning to the break we proceeded still through the Vale of the Severn (though of a character less flat than we find on our own side of the river) to Little Dean, where even the breakfast provided for us was not more welcome than the sight of Dr. Daubeny, who had come there to join our party in the Forest. Leaving Little Dean we ascended the steep hill which gave us a glorious view of the Vale of the Cotteswolds opposite—and, soon after bidding adieu to fields and cultivated land, we plunged into the forest wilds.

Whether it were that the tutelary genius of the Cotteswolds was here unable to protect us from the gnomes of the forest district, or that he had determined to punish us for our breach of bounds, I know not. But scarce had we lost sight of our own hills, when it appeared that the Undines or Naiads

rather than the Gnomes, had taken us in charge—and that steady and continuous down pour commenced, which I have known even on other occasions to welcome the unfrequent visitors to the Forest. From the top of Little Dean Hill, by Cinderford to the Speech House, we passed through scenery which in fair weather (for I can personally vouch that the weather there is *sometimes* fair) is of a rare beauty, and the roads too are good for horses who do not object to nearly perpendicular ascents and descents.

Subjects of interest to the Naturalist abound here at every step—a land of primeval Forest is invaluable to the Botanist or the Entomologist. The Mineralogist detects, in the very outline of the landscape, the bold and irregular forms of the old red sandstone, while heaps of ochre, furnaces of iron, and pits of coal attest the mineral treasures of the region, and the Ornithologist sees, not unfrequently, the now rather rare and always beautiful fork-tailed kite wheeling his graceful circles overhead. But alas, in a hard rain, the only circle to be seen overhead is the grateful but not graceful one of the umbrellas, and though to the right and left we occasionally caught glimpses of giant oaks and fine hollies—though now and then a ray of light shewed us a noble extent of the hill and valley of the ancient Forest, yet it so soon was lost that we were not tempted to leave our vehicle till we reached the Speech House. This is a curious building—as nearly as may be in the centre of the Forest—containing, besides a small Inn, the courts where the Forest law has for centuries been administered by the Verderers or Officers of the Crown, sworn to try all offences against the Queen's Vert and Venison. The original Hall has lately been altered and *improved*, I should rather say *done up*—being abridged of much of its fair proportions, and made comfortable and comparatively uninteresting.

From the Speech House we proceeded towards Coleford, somewhat better equipped against the weather than we had previously been, inasmuch as I find recorded in the Annals of the Cotteswolds Club, that one of our members rendered illustrious a piece of stair carpet, by borrowing it to wear as a plaid (like Hampden) “glad he could escape soe.”

Arrived at Coleford through equally beautiful but equally hidden scenery, we found that two hours yet remained before dinner, and the question arose, should we dry ourselves, or should we walk three miles through rain and fog to the Buckstone. Honour is due to the undaunted hearts who decided for the latter, and in a pelting rain we again sallied forth. But here we had our reward. Scarcely had we penetrated the thick brushwood which lines the summit of a hill overlooking the lovely valley of the Wye, and saw before us that singular mass of a conglomerate of quartz pebbles, which is called the Buckstone, standing on a point—apparently so insecure, yet having survived the rise and ruin of man's stateliest structures—than suddenly the rain ceased, the sun broke forth, somewhat dark and lowering indeed, but with all that distinctness of the outline and that charm of light and shade which is ever given by a stormy day to a mountainous prospect. After half an hour's enjoyment of this unexpected pleasure, the rain again commenced and we returned to Coleford, and after dinner to Gloucester, whence some of our bold brethren carried out their determination of returning at once to Cirencester, and reached it, as I am informed, within the four and twenty hours from the time they had left it.

I have taken much time in describing this excursion—partly because it took place in a district which is but little known to many of the people of our country—partly because that district is one of the most rich and varied both in interesting productions of nature and in valuable materials for art, but more than either—because the good humour and enjoyment which pervaded our party from first to last, shewed that, however any pleasure might be increased by fine weather, our spirits did not sink with the barometer, and that our love of Nature was not dependant on her holiday smiles and her gala dress, but that we loved her for her own sake and in all her varied forms, as an object worthy alike of our study and veneration.

On the third gathering of our Club, on October the 6th (for I must hurry

through many of our meetings), we accepted the hospitable invitation of Mr. Bayly to breakfast with him at Brookthorpe Vicarage, and then proceeding up the hill to the Horsepools Inn, skirted the summits of the Ridge, to the noble British encampment of Painswick Beacon, which looks loftily over that plain which appears from the Vale to form the summit of the Cotteswolds. Those who had the good fortune to be there will not forget Mr. Strickland's lecture on the Geology of the Vale from that commanding point, where the eye passes over Robin Hood's Hill (or Robin's Wood Hill) isolated by the Lias but capped with the Inferior Oolite, to the Volcanic Sienite of the Malverns, the Caradoc sandstone of May Hill, the coal measures and the old red sandstone of the Forest of Dean.

Our fourth meeting took place on December the 1st, 1846, at Hardwicke Court, where, if the other members of the Club enjoyed their reception one-half as much as the President enjoyed their company, all must have spent a happy day. Some collections of birds, prints, and dried plants, were examined, and among the latter a specimen of the *Epipactis rubra*, determined several of our botanical members to make, what I fear has hitherto proved, a vain search for it—though it was at the same time determined, with the spirit of true naturalists, that should it be found there should be no wanton destruction of a plant now become extremely rare if not extinct in this country.

The first meeting in 1847 took place on the 13th of April at Cirencester. I was unable to attend as I was Sheriff and the Assizes were going on, but I find that those members who were more fortunate than myself visited the Roman Pavement near Mr. Anderson's house in the Park. The fine Flemish and Suffolk cart horses in Lord Bathurst's farm buildings. The Agricultural College then of considerable interest, though less so than now in its more perfect state, and the curious slip in the strata which is seen in the cutting of the Great Western Railway near the end of the Sapperton tunnel. The evening was rendered interesting by Mr. Woodward's paper on the geology of the district embraced by the Club.

On May the 18th the meeting of the Yeomanry, at Bristol, again detained me from the Cotteswolds Club, who assembled at the Bear Inn, on Rodborough Common, and although they found on this side of the hill many of the beautiful anemone pulsatilla, yet, with a most praiseworthy moderation, they only bore away one or two specimens, that they might not wantonly rob even a common of its objects of great interest and beauty. Crossing the valley by Woodchester, beneath the turf of which rest some of the most beautiful Roman tessellated pavements in England, but which are only uncovered once in every five or six years, the party proceeded up the hill and through the long wood to Frocester Hill, which, if it affords less of a panoramic view than many other points, yields to none in the rich and varied character of its foreground. Returning through Woodchester Park to the Bear, the evening was signalized by the interesting paper by Dr. Wright on the anatomy of the mandible of the *Geophilus longicornis* which appears in our annals.

On July the 2nd the Cotteswolds Naturalists met at Cholford, and in the course of a most interesting walk, we examined three Churches and two Manufactories. Looking to our name as the Cotteswolds *Naturalists*, this scarcely appears a satisfactorily spent day, but we must remember that the first rule of our Club is, that our object shall be to investigate the Natural History, Antiquities, and Agriculture, and other objects worthy of interest in the Cotteswolds district and its neighbourhood; and where could we find objects of higher interest than Bussage, Oakridge, and Frampton Churches—all built by private charity in late years in hamlets far from any other church. For the manufactories, one at least may claim an intimate connection with agriculture, as its object is to make paper from straw, and, thanks to the kindness of Mr. Cochrane, who shewed us the process, it came peculiarly under the head of objects of interest. The paper will not indeed bear folding well, but it answers admirably for packing goods, and

the demand for it had lately obliged Mr. Cochrane to add largely to his premises.

On the 3rd of August the angry tumult of the County Election detained me from the far more pleasing studies of nature—but the Club breakfasted at Purton Vicarage, by the kind invitation of Mr. Prower, from whence they walked to the Roman encampment at Ringsbury, and on to Lydiard Millicent, where examining a deep well which was being dug in the village, I find that they discovered not an *Ichthyosaurus*, to raise conjecture as to its own history, but, far better, Professor Daubeny, ready to explain to them the hidden meaning of the leaves of that stone book which the labourers, like the worm, had simply bored through.

On returning to the Vicarage, Mr. Light displayed some very beautiful cases of Insects and of chalk fossils from his own neighbourhood, and Mr. Lycett read the interesting paper, which is printed in our transactions, "On the Fossil Conchology of the Great Oolite of Minchinhampton, compared with that of the same formation in other localities," and Dr. Daubeny kindly invited the Club to hold its winter meeting at Oxford.

On Wednesday, September 15th, I was again detained from the meeting by Yeomanry duties, but a small party, who would not however vote themselves a regular meeting, assembled at Shurdington, and walked through Badgeworth, by the remains of the Roman Villa near Witcombe, visited by the Club at our first meeting, to Cooper's Hill, and thence through Great Witcombe to the quarries of Crickley Hill, and thus ended the second summer of our existence as a club.

On December 7th we met at the Botanical Gardens at Oxford, by the kind invitation of Dr. Daubeny. I am loth to notice so lightly the objects of interest which were unfolded to us by the preparation of our kind host, and the attention of many of the eminent Professors of the University, who themselves shewed us their museums, but were I to attempt to record even my own recollections at this period, I will not say that I should weary you, for the subjects are so full of interest, that even my narration would scarcely deprive them of it—but I should detain you for an unseemly and inconvenient length of time. The only alternative is simply to mention the names of the collections we saw, and to leave it to the memory of those present to recall the varied pleasures of the day. Suffice it then to say, that our member, Mr. Strickland, shewed us the Ashmolean Museum, and Dr. Buckland's Geological Museum in the old Clarendon. Mr. Walker shewed us his collection of Apparatus for instruction in Physics. Dr. Acland explained the collection, which he has so much increased, in the anatomy schools, and we then returned to the Botanical Gardens to hear a lecture from our kind host on Volcanoes, as agents of great importance to Agriculture, both by varying the surface of the ground, and by the creation of necessary gases and the fertilization of the soil.

We then accompanied the Professor through the garden, and after dining at his hospitable board, concluded a day of rare enjoyment, to meet however at breakfast next morning at Mr. and Mrs. Strickland's, and enjoy his museum of Ornithology, and a walk through the Taylor Buildings, before we bade adieu to Oxford.

On May the 2nd, 1848, an invitation to breakfast with the Honorary Secretary, appeared to muster the Club in almost overwhelming numbers, and had such a gathering occurred in one of the small hosteleries we most usually frequent, we had been hard put to it. After breakfast Dr. Daubeny gave us an interesting account of the fossil bone earth found in Suffolk and in Dorsetshire, which so far tended to fulfil a prediction of Liebig, that, as the northern districts of our Island possessed the Coal and Iron mines, so important to a great manufacturing district—so it would probably be found that the southern portions possessed those materials most adapted for the promotion of Agriculture. The Honorary Secretary then shewed us his curious apparatus for hatching eggs by steam, in which we wished him all possible success, and we proceeded to the Royal Agricultural College,

where Professor Buckman displayed the already valuable museum of Natural History, and Professor Wilson accompanied us round the flourishing farm.

On Tuesday, June 13, we met at the Spread Eagle at Gloucester, and walked to Churchdown Hill, from the summit of which Mr. Buckman explained to us a most interesting theory of a Strait of the Sea having at one time probably separated England from Wales, but which has long risen into dry land; which led some of us to speculations, whether the Irish Channel might not some day rise, and unite us, in like manner, with the sister Isle by a Union not easily repealed.

On Tuesday, Aug. 8th, the Club met at Minchinhampton, and enjoyed the choice and beautiful collection of fossils made by Mr. Lycett, who then accompanied them to the quarries in the neighbourhood, whence his patience and skill has procured them, and where he has been rewarded by the discovery of several shells new to science. And on Tuesday, Sept. 26th, we met at Stonehouse, and walked where Fretherne Cliff overhanging the Severn near the lower part of the horse shoe, by its frequently crumbling affords constant interest to the Geologist; and though on our return Mr. Buckman seemed to fear that instead of finding mistletoe in Gloucestershire oaks, it was only found in a *hoax*, yet I am assured that the rare specimen still actually exists, though in a different tree to those we had searched.

Forgive me, Gentlemen, if I have dwelt too long on the recapitulation of these our meetings, but I, for my part, have received so much pleasure from them, and so much information relative to my own county and neighbourhood, that if you have enjoyed them as I have, you will not grudge the having them again separately recalled to your recollections.

And now let me say a few words on our general objects. I remember being asked, some time ago, "What is the aim or end of such a meeting; can you hope to make in this district any discoveries new to science, and to throw a light hitherto unknown on the world? or, if you do discover a new fossil shell, or a new insect, what will the world be the better for it?"—To this I can only answer, "Our object is not so much the hope of making *the world* better, as to make ourselves better. We seek a healthy, a most fascinating, far more than either, a most holy study. For what is the study of Natural History, but an approach to the Creator through his works? Nor do I believe, that He who has charged us, not only to read, but diligently to mark and learn the Bible, plain and distinct as much of it is, yet so deep in its wisdom, that no man, however much he may have pored over it, will say that he has mastered it and need study it no more; I cannot, I say, believe that He has given us those wonderful books of stone, which lie in the earth, in which He has placed characters, hard to be read indeed at first, yet rewarding the patient investigator with chronicles that can scarcely be mistaken—and that He has not intended that we should read them, were it but to bring more clearly to our dull conceptions that greatness which our highest imaginations can never reach."

I cannot believe that He has permitted us (for all knowledge comes only by His permission) to acquire the power of the microscope, which enables us to discover so much of the nature of what is sometimes called "the meanest insect," had He not intended to convince us by our own senses, that nothing which He has created can be called mean—and though the farther we proceed in the study, the more we find yet to be learned—yet, with the sense of our own ignorance, increases also our sense of the wisdom of Him who is seen over all and in all His works.

If we take up the study of Natural History with this feeling—and without such a feeling let none venture to approach it—the ultimate object of our Society is indeed a high one, and if the *means* be a pure and healthful recreation from the more fatiguing (and very necessary) yet not more noble employments of every day life, let us trust that we may long be permitted to receive aid and assistance from each other, in that noble study, the pursuit of which is the object of the Cotteswolds Club.

On the Poison Gland in the Jaw of Geophilus longicornis.

By THOMAS P. WRIGHT, Esq., M.D., &c.

At a Meeting of the Cotteswolds Naturalists' Club, held at Rodborough Common, May 18th, 1847, Dr. Wright, of Cheltenham, exhibited a beautiful preparation of the *Geophilus longicornis*, Leach, in which he had observed the venomiferous glands of that Myriapod. He had found no description of these glands in any of the great authorities on the structure of the articulate animals whom he had consulted, from which he inferred that these bodies had hitherto escaped observation.

Dr. Wright observed that the salivary glands in the vertebrate animals are in general absent in those classes and tribes which live habitually in water. In Fishes they are absent, an increased mucous secretion being poured into the mouth by a great development of the buccal follicles. In Batrachia distinct glands are absent, a compensative secretion being supplied by the mucous glands of the mouth and tongue. In the Cetacea they exist only in a rudimentary state. Hence the conclusion that animals that seize their prey in the water, and swallow it without mastication, have no necessity for saliva as a preliminary solvent for the digestive process, the gastric juice in these animals being sufficient to complete the chemical changes in the stomach. In the invertebrate classes salivary glands are absent in all the Radiata, nor do we observe these bodies in the Tunicated or Acephalous Mollusca; but they are found in the Gasteropoda and Cephalopoda; they are absent in the Entozoa, but exist in a rudimentary state in the Annelida and Crustacea. In all the classes of the Articulata that respire air, as Myriapoda, Insecta, and Arachnida, salivary vessels can be demonstrated: these organs may be subdivided into simple and compound glands.

A. When the secretion supplied is a fluid concerned in the digestive process, the secreting organ is a simple tube with its distal extremity closed.

B. When the secretion supplied is used for the destruction of prey, the secreting organ is a compound body or gland.

In the majority of Insecta the salivary vessels are simple ramified tubes that open into the gullet, but in Hemiptera simple tubes and glandular bodies coexist; the former I regard as the true salivary organs, the latter as venomiferous glands for the destruction of prey. In *Nepa*, *Notonecta*, *Nasus*, and *Ranatra* these bodies are beautifully developed.

In pulmonary Arachnida the venomiferous glands are situated in the cephalothorax; their excretory ducts arise from the anterior part of the gland and traverse a minute canal in the mandibles, and open at the perforated extremity of these organs.

In Myriapoda, as in the preparation of *Geophilus longicornis* now before us, the venomiferous glands lie at the base of the mandibles among the striped or voluntary muscles that occupy this region. With an inch glass

we see these organs most satisfactorily ; they consist of two oblong compact bodies composed of bundles of diaphanous cells closely pressed together and inclosed in a distinct capsule reposing loosely at the base of the jaws and occupying the hollow part of these organs ; from the anterior part of the gland rises a single excretory duct, which passes forwards in an arched direction, and enters a canal in the horny part of the perforated jaw, and opens near its apex, as in the Arachnida. By this mechanism, when *Geophilus* inserts its mandibles into the body of its victims, it at the same moment introduces a poison into the wound which destroys life, after the same principle as the parotid glands in some ophidian reptiles, as *Crotalus*, *Naja* and *Vipera*, are metamorphosed into veneniferous glands for the destruction of living prey. After this communication was made, Dr. Wright demonstrated the preparation to the members of the Club, and exhibited the singular structure with the aid of the microscope.

A few general Remarks on the Fossil Conchology of the Great Oolite of Minchinhampton in comparison with that of the same Formation in other localities. By JOHN LYCETT, Esq.

THE following observations have been suggested to me by a remark of Dr. Buckland in his "Bridgewater Treatise," and which has since been occasionally quoted and repeated by others; in effect, that during the vast period when the secondary formations were in process of deposition, a molluscan class (the carnivorous Trachelipods), which in our present seas perform the office of keeping down within due limits the other molluscan races, did not then exist, or that they were extremely few, and that it was only on the extinction of those extensive genera of Cephalopods, the Ammonites and Belemnites, at the commencement of the tertiary epoch, that the carnivorous or Trachelipods made their appearance. Living in a district distinguished by a great profusion of molluscan remains, a large proportion of which are absolutely unknown to science, a favourable opportunity for testing the correctness of the foregoing theory was presented to me, more especially as these remains occur in an unusually good state of preservation, extending in some instances even to the original colours of univalves, the hinges of the bivalves, and the external ligament of the hinge in the latter shells. Before however stating the results of this inquiry, a very brief sketch of the physical and geological characters of the district may not be unacceptable to the members.

A circle having a radius of only four miles, with the town of Minchinhampton in the centre, will comprise the whole district to which these fossils refer. The Bath Oolite, or Compound Great Oolite as it is now termed by geologists, is the uppermost formation; its continuity is however broken by two great valleys of denudation, the vales of Brimscomb and Woodchester, which, with their numerous lateral ramifications, have cut through the whole series of rocks from the upper part of the Great Oolite to the middle of the lias inclusive, having a mean depth of 500 feet, thereby producing a combination of circumstances eminently favourable for exposing the useful beds of stone and conveying it by water-carriage.

The divisions of the Compound Great Oolite are, Great Oolite and Fuller's Earth, the former having a thickness of 130 and the latter of 70 feet. At some few localities the base of the Great Oolite has one or two beds of true Stonesfield slate associated with brown marls. In this respect however, as in the mineral character of the formation generally, the greatest variety and uncertainty exist; opposite sides of the same quarry will often exhibit such a change; thus an Oolitic and shelly limestone will pass into a barren sandstone. Keeping this fact in view, a considerable latitude must be allowed in the following arrangement, which is given only as a general and approximate view of the whole series of beds. The Great Oolite proper may be conveniently subdivided into three series of beds, an upper and lower fossiliferous, often serviceable for building purposes, and a middle, more barren and unserviceable. Beginning with the uppermost, or those

which immediately underlie the Bradford clay, we find an alternating series of limestones and clays or marls, extremely variable both in thickness and extent. Certain of these bands, and more especially one of a compact cream-coloured limestone, are eminently shelly, but will seldom allow of the shells being separated entire. These gradually pass downwards into the middle subdivision, where the rock is more barren of organic remains, and sandy.

The lower subdivision assumes a very different aspect; we here find 35 or 40 feet of shelly beds, separating into large masses, and well-suited for the mason. From the third or lower subdivision it is that nearly the whole of our fossils are derived, the stone usually admitting their being cleaved with a knife.

The uppermost portion of this series, the planking*, which is from 8 to 10 feet thick, contains the most numerous suite of zoophagous Trachelipoda, several of which are not found beneath it. To this succeeds a few feet of incoherent sandy rock, the upper part of which is nearly destitute of shells, or only occupied by a few species of small bivalves. The shells gradually increase in number downwards, and repose on several beds of hard shelly rock, locally called Weatherstone. Here more especially abound the valves of small oysters, which at length constitute no inconsiderable portion of the mass, and whose peculiar structure imparts such great hardness to the deposit, that the lower few inches strike fire with the tools of the workmen.

These shelly beds or weatherstones have a high character for durability; they have a coarse aspect; when once dried by exposure to the sun they do not readily absorb water, and consequently resist the action of frost; a careful selection is however necessary to ensure this desideratum. The south transept of Minchinhampton church, five centuries old, is built of this stone, and notwithstanding its very exposed situation, displays all the sharpness and distinctness in its angles and carving which we should expect in a modern edifice.

The Fuller's earth which underlies these deposits is but partially and imperfectly exposed within the district; it consists of a series of brown and blue marls and clays traversed by three or four bands of a hard argillaceous rock locally called clay rag. Some portions of the clays, and more especially the rag-stones, are made up of the valves of small oysters, chiefly *Ostrea acuminata*; the organic remains, however, are far from numerous, when counted by number of species; they are nearly all bivalves, and I have not observed any which are not likewise found in the weatherstones above. The Fuller's earth constitutes the most fertile soil in this part of the county; when properly drained it is well-adapted for pasturage and orchards, which together with a good supply of water derived from the superincumbent Oolite, has made it in populous districts the chosen seat of man's habitation; accordingly its course may be traced by a belt or terrace, more or less wide, of houses and gardens encircling the hill-sides. Landslips from such a yielding deposit, as might be expected, are frequent, and thereby render the barren slope of the Inferior Oolite fertile: a coating of its marls sometimes extends even down to the lias. The numerical proportion of species obtained by me from the Minchinhampton Great Oolite are in number as follows:—

Bivalves, 164, Univalves, 141, Radiata, 13, Cephalopoda, 9. Of the latter 6 are Ammonites; these are so scarce, that 50 specimens probably exceed the entire number. Of *Nautili* there are two species, one of which has furnished only three specimens, and the other is far from numerous. The Belemnites have only one species, small and likewise scarce.

Of the 141 Univalves 45 pertain to carnivorous genera, exclusive of 8 species of *Phasianella*, the living shells of which are now known to be both carnivorous and phytophagous. These genera are, *Neritæa* 13 species, *Cerithium* 5, *Murex* 6, *Buccinum* 2; a new group of large shells belonging to the *Muricidæ*, to which as yet no generic appellation has been given,

* A local term indicating a thin-bedded stone.

4 species; *Pleurotoma* 1; *Hippocrenes*, a group of winged shells differing from the *Rostellaria* of the recent period, 10 species; *Fusus*, or a group at least belonging to the *Fusina*, 4 species.

This extreme paucity of the Cephalopoda, taken in connexion with the occurrence of numerous genera and species of carnivorous univalves, is a remarkable circumstance. We know that previously throughout the lias and inferior Oolite the Cephalopods reigned supreme amongst the molluscan tribes. Subsequently also the Oxford clay and Portland Oolite contained them in nearly equal profusion. With these facts before us, the inquiry naturally follows,—Were there any peculiar circumstances connected with the mineral character of the deposit at the locality in question, and what was the probable depth of the sea over the shelly beds; since we find here zoophagous tribes differing from those of warm seas at the present time not very materially either in number or in their generic affinities? First, with regard to the nature of the deposit, or at least the more shelly portions of it:—In the planking and Weatherstone beds we find heaps of broken shells piled diagonally, the bivalves rarely having both valves in apposition; with these are fragments of wood, crabs' claws, joints of Apicrinite and Pentaerinite, ossicula of Ophiura, palates and teeth of fishes, small bouldered fragments of Madrepores, and nodules of rock apparently foreign to the deposit: these conditions vary and change every few yards, as likewise does the mineral character of the beds;—the results, in fact, of littoral action; of a shallow sea where the shells were subjected to strong currents producing hasty deposits and frequent trituration. The Oolitic structure is rather scanty and very uncertain. As a complete contrast to these conditions, the Great Oolite in the vicinity of Bath may be cited. The rock is there thick-bedded; the Oolitic structure prevails; the shells are few, and those chiefly *Terebratulæ*; the denizens, it may be presumed, of a deep and tranquil sea, in which corals and sponges multiplied and attained large dimensions. In Mr. Lonsdale's list of 31 species of Mollusca from the Bradford clay, Bath Oolite and Fuller's earth of that neighbourhood, no less than eight are *Terebratulæ*, and a *Crania* has since been added; a larger number of Brachiopods than will be found in the 327 Minchinhampton species which I have tabulated.

The list given by Mr. Buckman, in his "Geology of Cheltenham," from the Bradford clay and Stonesfield slate of the Cotteswolds in the north-eastern part of this county, comprises 5 Radiaria, 2 *Terebratulæ*, 44 Bivalves, 6 Cephalopoda, and 19 Univalves. Stonesfield has yielded a rich store of remains of reptiles, fishes, crustacea and land plants, but the Conchological list is but meagre, and we are nearly destitute of information with regard to the shells of the Great Oolite in its long course through the counties of Northampton and Lincoln. Yorkshire, on the other hand, has found able illustrators in Phillips, Williamson and Bean, the latter gentleman having given, in the "Magazine of Natural History for 1839," a list of fossils from the stratum called Cornbrash in that county, consisting of 4 Radiaria, 3 Annulata, 91 Bivalves, 16 Univalves, and 3 Cephalopoda. Unfortunately, however, the rocks beneath the Oxford clay in that county form a great carboniferous series of deposits accumulated in an estuary, and will not allow of its subdivisions being identified with those of the middle and west of England. From this cause the shells have little more than a local value, since we cannot be sure that any particular stratum is contemporaneous with another in a different locality. On looking at these lists, together with those relating to the Oolitic rocks of France, Germany, and Switzerland, we are struck with the great paucity of univalves as compared with the small district of Minchinhampton.

A careful scrutiny however of various foreign works which bear upon the subject,—of the works of Goldfuss, Rœmer, Dunker, Deslongchamps, d'Archiac, &c.—has convinced me, that if any peculiarity exists with regard to the Minchinhampton fossils it is at least of a very limited nature, inasmuch as nearly one-half the entire numbers of bivalves can be identified

in those works, a considerable number being from the coral rag of Hohengelsen, which seems to be the equivalent of our Great Oolite. Among the univalves, the general resemblance to the Minchinhampton shells is so great, that at first we feel prepared to identify the greater number of them; a closer scrutiny undeceives us, and ultimately we are surprised at the very few which we can call our own. It may be suspected, indeed, that the meagre lists of univalves hitherto published relating to the formation in question are the result, not so much of an actual deficiency of those shells, as of the difficulty of separating them from the stone in a condition sufficiently well-preserved to admit of specific characters being recognized. The Oolite of our district itself furnishes an instance in illustration; almost the entire suite of univalves are procured from quarries to the north and west of the town, and even within those limits are certain localities from which the univalves can hardly be separated; but in the upper and middle subdivisions, to the east of the town, we can obtain but few, and those only which approach the globular figure, as *Natica* and *Bulla*, usually in the form of casts; with slender spiral shells the attempt is hopeless. These circumstances however are altogether independent of the great fact forced upon our attention—viz., the scarcity and almost entire disappearance of the Cephalopoda from the sea of this portion of the Cotswolds during a period in which deposits 200 feet in thickness were formed, and the simultaneous appearance of a large number of new and more simple forms to supply their place.

With our present very scanty knowledge of the circumstances which conduce to change of species on the floor of the sea, reasoning would be little better than conjecture; I have therefore rather preferred to state facts as they are presented to my notice, reflecting that every such contribution, however insignificant, is something added to the general store of knowledge, and consequently an aid to our conceptions of the operation of that infinite and all-pervading wisdom which is exemplified equally in the lowest as in the highest beings of creation.

Hence, though it is well known (as above quoted from Dr. Buckland) that throughout the vast deposits of the secondary rocks those important tribes of Cephalopods, the Ammonites and Belemnites, reigned supreme amongst the molluscous races, and that they became extinct prior to the commencement of the tertiary aera, their paucity in the Great Oolite of Minchinhampton would lead us to infer that some peculiar conditions of sea-bottom existed at that locality which were unfavourable to their increase. But so far from the carnivorous Trachelipods "not having existed prior to the commencement of the tertiary aera," we here find them in the middle of the secondary deposits in great force and variety, forming in fact a considerable proportion of the whole number of univalves, and consequently existing long before the extinction of the Ammonites and Belemnites.

It is highly probable that Dr. Buckland would not now adhere to the above theory, stated some ten or eleven years ago; but having the authority of his name and occurring in a standard work, it still passes current with the reading public, and has frequently been quoted by subsequent writers.

On a future occasion I anticipate the pleasure of presenting to the Club some remarks more in detail on the new or less-known molluscous forms which occur in this formation. The Inferior Oolite within the narrow limits of my observation has likewise yielded a considerable store of novel materials for investigation: these would require a separate communication.

Notes on the distribution of the Fossil Conchology of the Oolitic Formations in the vicinity of Minchinhampton, Gloucestershire. By JOHN LYCETT, Esq.

READ 8TH AUGUST, 1848.

THE following remarks have been written chiefly with a view to illustrate the contents of the author's cabinet, premising that the objects in question constitute materials fitted rather for private study than for public demonstration. The bones of gigantic Saurian reptiles, of fishes, the shells of great Cephalopods, are appreciated even by the uninstructed spectator. They speak to his senses of a creation distinct from that which he sees around him, and he is prepared to hear of further wonders when the voice of comparative anatomy tells him of their organization and consequent habits. None of these fall within the scope of my remarks; they are absent: we know that they existed contemporaneously with the deposition of these rocks and their included fossils: Stonesfield in this country, Pappenheim and Solenhofen in Germany assure us of this. Speaking with the caution which the subject demands, it may be asserted that the conditions of sea-bottom in our neighbourhood, though varying considerably during the time which was required for an accumulation of 400 feet in vertical thickness of solid rock, and the creation and extinction of many forms of molluscous animals, at no time constituted the estuary of a great river. We search in vain for the relics of air-breathing animals and plants periodically carried down and spread over its floor. The only vegetable remains are fragments of wood which may have floated on the ocean wave to whatever quarter the winds and currents directed them.

With the great Saurians the case was different; whether denizens of the land, of rivers, or of estuary waters, their remains were entombed in the fine mud which fluvial waters deposit so copiously.

We should not expect, nor do we find, a large number of marine shells associated with such deposits; their paucity is perfectly compatible with what we know of brackish waters of the recent period, and the small number of marine species which they furnish. Precluded then from displaying this description of fossil treasures, we revert to the less striking remains of molluscous animals, and these from their number, their association, their separation into distinct groups and other circumstances repeated at different periods, acquire an interest distinct from that which would attach to them as mere examples of fossil conchology. To illustrate therefore this portion of the subject the present memoir is chiefly directed, interspersed with notices of such remarkable or characteristic forms as have hitherto been imperfectly described, or which impart to these assemblages their prominent and distinguishing features.

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Commencing with the upper portion of the Great Oolite in our vicinity, we find several beds of hard limestone and bands of marly clay, containing a series of shells representing in diminished numbers the inhabitants of the lower and richer fossiliferous beds of the formation. Several which do not occur in the lower group I will notice; these are the little *Cardium Beaumonti* (Archiac), very abundant, *Pholadomya nana* (Phillips), *Chemnitzia*, new species, *Bulla Hildenensis* (Römer), *Bulla suprajurensis* (Römer), *Cardium pes-bovis* (Archiac), *Cardilla grandis*, new species. The other forms which commonly occur are *Lucina tyrata* (Phillips), *Lucina rotundata* (Römer), *Ceromya semi-striata*, new species, *Ceromya excentrica* (*Isocardia*, Römer). We have been fortunate enough to succeed in clearing the hinges of the two latter species, and have thus ascertained that they have nothing in common with *Isocardia*, but belong to the new genus *Ceromya* of Agassiz. *Isocardia concentrica* must likewise be placed in the same genus.

Quitting these beds and descending through sandstones nearly destitute of organic remains, we arrive at the shelly Oolite locally termed *planking*, or upper beds of the Great Oolite building stone, a marine deposit distinguished by the great profusion of its fossil conchology and their good state of preservation. Here at one locality we find a large assemblage of a genus which seems to be characteristic of this formation and especially of this vicinity; I allude to the new genus *Purpuroidea*, of which the generic characters are as follows:—

Shell turreted, ventricose, aperture large, apex of the spire pointed. Spire consisting of several whorls usually convex, and having about their middle part a circle of tubercles or blunt spines. Columella smooth, rounded, and curved inwards at its base. Notch wide, but not deep nor recurved. Outer lip thin, slightly sinuated, and forming an acute angle posteriorly at its junction with the body whorl. The casts of the interior are smooth, or exhibit but faint indications of the tubercles, and none of the ribs or striæ which distinguish the perfect shells. The axial umbilicus is usually very conspicuous and the basal notch not distinguishable. They would certainly be taken for *Natica* by persons not conversant with the outer form, and even appear to have been figured as such by Römer under the title of *Natica subnodosa* from the Oolite of Hanover. One of the species has twice been imperfectly figured in English works; first in Young and Bird's "Geology of the Yorkshire Coast," as *Meruz nodulatus*; the figure is merely a rude sketch of a bad specimen, but characteristic; subsequently a figure representing little more than a cast was given in the "Mineral Conchology," as *Meruz tuberosus*. The varieties of form and markings which two of the species exhibit are worthy of notice; the most abundant shell, *P. rugosa*, when young and the size of a nut, has tubercles in lieu of spines; the transverse ribs are well-defined; but the longitudinal elevations which give the species a rugose aspect are absent, the basal notch is nearly obsolete, and the columella is nearly straight. The *P. nodulata* has still greater varieties; when full-grown it has two encircling rows of tubercles on the body whorl, from the lower and smaller of which proceed oblique longitudinal ribs which terminate in a transverse elevated basal belt. The young shell is nearly smooth; the smaller circle of tubercles is scarcely distinguishable; the ribs are absent, as is likewise the basal belt. Occasionally in full-grown specimens the smaller circle of tubercles degenerates into an encircling rib. The spire is of various degrees of elevation, in fact scarcely any two specimens are exactly alike; a considerable number are therefore desirable for its full elucidation. The third species, *P. glabrata*, is rare; it equals the others in magnitude. It is seldom that we can trace the limits of a species over any particular area; here however we are enabled to do so with tolerable accuracy. These shells are grouped together in the blocks of stone by hundreds, occupying a vertical thickness of 5 or 6 feet, and spread over an area 50 yards wide and 100 long. It is to be regretted that this prolific space will ere long be entirely removed, and

the *Purpuroides* in its perfect state will probably be only a matter of tradition as far as this vicinity is concerned. These conditions have produced upon our mind the impression that here we perhaps behold the birth-place or original seat from whence the diffusion of the genus took place. Repeated observations have shown that specimens occur in every other quarry in the neighbourhood, but so rarely, that the total number noticed probably has not exceeded twenty in the course of the last six years. Higher in the series they are met with in several beds of compact homogeneous limestone, but much more sparingly than in the planking, and from the hard structure of the rock can only be separated in the form of the *Natica*-like casts.

The *Patella*, which occur abundantly in our shelly Oolite, like their recent congeners, vary so considerably as sometimes to puzzle even persons who have been accustomed to their peculiarities. The most common species, *P. rugosa*, when obtained south of the vale of Brimscomb, fully deserves its name, but north of the vale it loses much of the rugose aspect caused by the lines of growth, the longitudinal striæ are faintly marked, and the shell is altogether extremely thin. In a very young state the form is a longer oval and much less elevated, the apex being slightly turned to the right side, constituting the *Patella ancilloides* of the "Mineral Conchology," which species should therefore be expunged. *Patella Aubentonensis* (Archiac) occasionally loses its striæ altogether, and this change is not confined to any particular size or form of shell. *Patella nana* in advanced age is spread out more horizontally towards its borders, and forms a concave conical and ovate shell. The fine encircling striæ then altogether disappear; the minute figure in the "Mineral Conchology" refers to the shell in its young state.

The genus *Nerinea* is represented by upwards of fourteen species, of which five are abundant; they seem to occupy in the Oolitic rocks the place of the *Cerithia* of the older tertiary strata, and are decidedly the predominating univalve of their period. Our most common species are destitute of the tubercles or striæ by which these shells are usually ornamented; four only of the species appear to have been figured or described. One fact in connexion with the extinct carnivorous trachelipods should be noticed. The recent genera of that class are furnished with a tubular boring apparatus, by means of which they drill round holes in the bivalves and prey upon their juices. As none of the Oolitic bivalves have such perforations, we may conclude that the extinct carnivorous genera of that period were differently constituted.

Of the *Natica* we number fourteen species, seven of which are new; although the species are thus numerous, one only, *N. Michelini* (Archiac), is at all common.

The family of the winged shells, or *Strombida*, are represented by upwards of eleven species belonging to the same genus; the greater number of these likewise occur even to the base of the formation. We have separated them from the *Rostellarias* and *Pteroceras* under the generic term *Rostrotrema*; they are distinguished from the true *Rostellarias* by the absence of an upper or posterior siphon upon the spire, the outer lip not extending beyond the body whorl or but slightly upon the penultimate, and there is no corresponding thickening upon the inner lip to form a channel. It is true that one or two recent species of *Rostellaria* have no posterior siphon upon the spire, but in such instances the siphon is present and coiled round upon the upper part of the wing. From *Strombus* it is sufficiently distinguished by the absence of the sinus on the outer lip. We venture to suggest that the *Strombida* requires a re-arrangement, the digitations of the outer lip not being of sufficient importance to found upon them generic distinctions: they are of too variable a character, and in some instances depend very much upon the age of the specimen.

Another generic form, as yet found in no other part of England, is a conical turbinated univalve, called by me *Trochotoma*; five species occur, but only one is common. Its distinguishing generic feature is a transverse

flesse upon the body whorl, which approaches the outer lip, but does not reach it. This alone is sufficient to distinguish it from *Pleurotomaria*, from which also the base materially differs, its deep concavity resembling an umbilicus and giving to the aperture a semilunar figure.

The outer lip is thick, the whorls usually angular and concentrically stratified. They occur throughout all the lower fossiliferous beds. Perhaps I may be excused for briefly alluding to the name given to this shell, although the matter is of a somewhat personal nature. In the autumn of 1841, finding that this form was entirely unknown, I forwarded a specimen to Pro. Sedgwick as a new genus, and mentioned that I proposed to call it *Trochotoma*: about the same time a gentleman who then collected largely from our Great Oolite and distributed its fossils widely always affixed to it the name which I had proposed to give it, so that the appellation became current wherever a collection of our fossils existed six years ago. Within two years afterwards Professor Ansted figured one of the species in his work on Geology under the same name. Knowing these facts, my surprise may be imagined, when lately turning to the new work on Natural History by Pictet, published at Geneva, I found that he had described this genus under a new name, saying that this is the *Trochotoma* of M. Deslongchamps, and referring to a paper by that gentleman on the Great Oolite of Normandy, published in the 7th volume of the 'Transactions' of the Linnæan Society of Normandy in 1842. In that memoir are figured and described five species, of which three are found in this vicinity. It would therefore appear that M. Deslongchamps must have read his paper to the Society in 1841, and nearly simultaneously with myself must have imagined the same new word as a designation for a certain new form. The paper in question is even now so little known in this country that I was compelled to resort to the British Museum to see a copy of it. Probably another coincidence exactly similar to this is not upon record.

It is proposed to restore the forgotten term *Cylindrites* used by Llywhyd as a generic name for a form which requires to be distinguished, and which appears to be very characteristic both of this rock and the Inferior Oolite. We possess six species, three of which have been figured, two as *Actæon* in the "Mineral Conchology," and one as *Conus* by Archiac; the generic characters are as follows:—Form cylindrical. Spire small, acute, sometimes not rising above the body whorl but always exposed; whorls several, usually flat, sulcated at their junctions. Aperture elongated, narrow, almost linear. Columella with two folds at its base, which is slightly turned outwards at that part; base of the aperture entire, outer lip thin. All the species are distinct from those of the Inferior Oolite.

Before quitting this assemblage of shells, another form which has occasioned me much perplexity must be noticed. It is called by Rømer *Placuna jurensis*, but is clearly distinct from that genus, of which it does not possess the cardinal teeth, nor has it the hole or appendage of *Anomia*. The following are the grounds upon which it is deemed proper to erect it into a distinct genus.

Generic Character.—Shell very thin, irregular, either convex or flat, posterior border rounded, anterior border more straight; apex little elevated, but always distinct and placed near to the middle of the anterior border. Fine longitudinal closely arranged waved striæ radiate from the apex on every side; the under surface is smooth with a large central impression.

These shells were frequently (perhaps always) attached to bivalves, more especially to *Trigonia*, not by the external surface but from the under side; the knobs and striæ proper to those shells causing the elevations upon the attached shells. From these circumstances it would appear that the soft parts of the parasite must have adhered to the *Trigonia* prior to the secretion of the thin shelly plate, and that the shelly matter was deposited during such adhesion. On the death of the parasite the thin plate separated, as there was no shelly adhesion between it and the *Trigonia*, and they are never found attached to the latter. With the scanty knowledge we possess

of this form, it would be unwise to speculate upon its affinities unless with great reserve and circumspection. The mode in which the markings of the *Trigonia* are transferred to this shell renders it very difficult to imagine that it could have been a bivalve. We look at it were upon an impression at the back of the paper, the parts in relief having been stamped through, it, but disguised by the finely striated surface at the back of the attached shell. It was sedentary, and if univalve may have belonged to those forms of the *Patelloidea* in which the shell is partially enveloped in the soft parts of the animals, examples of which are found in *Fissurella*, *Haliotis*, *Sigaretus*, and *Stomatia*. We would however wish it to be understood that these hints are thrown out chiefly to engage the attention of others, as we are by no means satisfied with the result of our own observations.

The estuary waters which entombed the varied remains at Stonesfield spread out partially a thin stratum of their muddy deposit to this neighbourhood, without carrying with it any of the forms for which that locality is so famous. Our Stonesfield slate has a few marine shells, among which are *Ammonites coronatus* (Orbigny), *A. Lalandeanus* (Orbigny), *Mya margaritifera* (Young), *Ceromya V. scripta* (Cardita, Buckman), *Cardium*, new species, *Anatina undulata* (*Sanguinolaria*, Phillips), *Mya dilata* (Phillips). As regards this neighbourhood, it may be stated as a general rule, that where the lower beds of Great Oolite are shelly, they repose immediately upon Fuller's earth; in the other condition the base is Stonesfield slate; probably the fine mud of the latter deposit was carried out to great depths almost beneath the region of shells. Our Fuller's earth is very imperfectly exposed, nor have any considerable number of species been obtained from it. The little *Ostrea acuminata* is found in great masses, which nearly composes the beds where it occurs. Not a single shell has been found peculiar to these beds.

The Inferior Oolite in the division of its beds in this locality does not differ materially from the description given by Mr. Buckman in his "Geology of Cheltenham," except towards the lower portion, which is strikingly dissimilar. It is not our intention to do more than allude to these conditions; a careful survey along the outer escarpment of the Cotteswolds would be required to enable us to understand the changes of mineral character, fossil contents, and perhaps thinning-out which certain beds must undergo in their short course between Painswick and Crickley Hill. Many doubts have been expressed by persons both in the metropolis and provinces as to the geological position of the rock from whence our Great Oolite fossils are derived; these doubts would seem to have arisen from a resemblance which portions of our rock and its fossils bear to a certain bed of the Inferior Oolite near Cheltenham.

Of the geological position of the rocks in our neighbourhood no person who has examined them can entertain any doubt; our sections, both natural and artificial, are numerous and of a decided character, affording what can rarely be seen elsewhere in one view, a complete escarpment from the Great Oolite to the Lias inclusive. The shells of the upper rag-stone agree closely with those from the Cheltenham sections. The cream-coloured marls and marly rock called "Fimbria bed," have however disclosed a remarkable suite of shells which must not be passed over in silence. The general aspect of these fossils, as contrasted with those of the upper and lower rag-stones, is striking. The association of genera strongly reminds us of the Great Oolite. The genus *Neritæa*, which is very rarely seen in the rag-stones, again reappears in vast profusion, to such an extent indeed that in some localities almost every fragment of marly rock discloses sections of this extinct form. Accompanying these are several species of small *Cerithia*, together with an equal variety of the genus *Chemnitzia*, comprising some of the most slender spirial univalves which it is possible to imagine. The *Rostrotrema*, though rare, are likewise represented by five species. We seem in fact to have a repetition of the circumstances under which the mollusca of the Great Oolite lived and multiplied. In a

former paper we alluded to an almost entire absence of the Cephalopoda which distinguishes our Great Oolite, and it would appear that this feature likewise extends to the same formation throughout France. Thus Archiac does not mention a single species in the district which he has illustrated, and Deslongchamps is equally silent in describing the Normandic fossils. The "Fimbria bed," in striking contrast to the other portions of the Inferior Oolite, is distinguished by a similar paucity of Cephalopoda; hitherto only a single specimen of Ammonite has been placed in our cabinet, and we have searched in vain for a Nautilus or Belemnite. There are several *Terebratula*, of which *T. fimbria* is the most abundant; the varieties of figure and markings which this shell undergoes in its stages of growth become interesting when placed beside a similar series of the recent *T. Australis*, which it very nearly resembles in every circumstance. Of the fossil species but few will be found to have attained the characters of old age, and these latter are rarely equal in size to those which died on attaining middle life, a fact of which some striking examples may be cited in certain recent shells. As the *T. Australis*, unlike the Brachiopoda generally, is found in water only knee-deep near Sidney, we may be allowed to consider it probable that the *Terebratulæ* and other shells of the Fimbria bed were likewise denizens of a shallow sea; such a condition would assist in explaining the absence of Cephalopoda and the general resemblance to the association of Great Oolite shells. As a last resemblance a general dwarfing species may be noticed, some examples of which will subsequently be given. This general resemblance however extends but in a very limited degree to specific identity; thus, of the seven *Nerineæ*, one only is common to both; the *Cerithia* are altogether different, as are likewise the *Chemnitzias* and *Cylindrites*. Our collection from the Fimbria bed contains—

59 Univalves and Radiaria, of which 22 are Great Oolite species.

72 Bivalves, of which 29 are Great Oolite species.

131

51

Thus only about 38 per cent. of the whole are common to both formations. On passing downward through the freestones these shells rapidly disappear, and on arriving at the lower rag-stones another and very dissimilar suite predominate; the profusion of *Nerineæ* has entirely vanished, and equally in vain might we look for a *Cerithium* or a *Rostrotrema*, and we very rarely meet with a *Chemnitzia*; the bivalves are again of full dimensions, and the Cephalopoda reappear in full force and of large size, but being difficult to extract entire, are rarely seen in the cabinets of collectors. But to form an idea of their numbers, the lowest bed in the escarpment at Frocester Hill should be visited; it is a perfect storehouse of this class of remains. Nor is this abundance confined to one locality; wherever the brown ochrey beds are exposed in the escarpments of our valleys, or on the outer line of the Cotteswolds, a single square yard of rock exposed is usually sufficient to produce fragments of Ammonites and Belemnites; and it would appear that a similar profusion of those forms distinguishes the lower beds of Inferior Oolite throughout the whole of its course in Somerset and Dorset. That they should entirely cease between Painswick Hill and Crickley Hill, to be replaced by other and totally different beds of rock and fossil contents, is one of the most interesting geological problems which the Cotteswolds offer to the scientific inquirer. A very remarkable Brachiopod marks the base of the formation in our district; *Terebratula bidens* occurs in the lower rag-stone, and more especially in a few inches of marly rock, sometimes called Gingerbread rock, which immediately underlies it. *Terebratula acuta* and *T. tridens* accompany it much more sparingly; the latter possibly may be only a variety of the first: the separation of species among the Brachiopoda must be regarded as merely provisional until the state of our knowledge respecting them shall be more advanced. The brown sands

beneath are entirely barren of organic relics, and gradually and insensibly merge into the Upper Lias.

The general diminutive appearance which the Great Oolite shells present when compared with those of the other Oolitic rocks cannot fail to be noticed. In species which have a considerable vertical range this fact is rendered particularly striking: thus, but for a perfect identity of markings, *Trigonia costata* reduced to the size of a bean, and sometimes even to a pea, would scarcely be regarded as the representative of the large Inferior Oolite shell: higher in the Oolites it again attains its pristine dimensions. *Astarte excavata* too, without the aid of a large series for comparison, would not be recognised; the shell becomes small, depressed, and the costæ rendered almost obsolete. *Modiola plicata*, which reappears in the upper beds of Great Oolite, nearly loses its plicæ, and acquires a compressed angular form. The changes of size which *Lucina lyrata* undergoes is still more remarkable. In the lower rag-stone it is of full dimensions; in the Nerinea bed or Fimbria bed it is reduced to one-fourth its former bulk; in the upper rag-stone it is again large; in the shelly beds of the Great Oolite it is rare, but is again reduced to the dimensions of the Fimbria bed; lastly, in the upper beds of the Great Oolite it is again abundant and of its standard bulk.

Next as to the gregarious habits of certain species:—Bussage, a small hamlet north of the vale of Brimscomb, produces in its shelly Great Oolite a large assemblage of an undescribed species of *Terebratula* somewhat resembling *T. globata*, but very rarely having both valves in juxtaposition, and seldom found in any other locality. In the limestone beds of the upper fossiliferous series, one locality has produced a dense assemblage of a fine bivalve which seems to belong to the new genus *Cardilla* of Deshayes, although generally in these beds it is rare. The compact structure of the rock renders it nearly impossible to disengage them in a perfect state, but the fine striæ of the shell are well preserved, and the character of the species evident; its sudden advance in size when compared with the small fossil shell upon which the genus was founded is remarkable, and justifies the specific appellation of *grandis*.

The association of species at the locality in question is curious; the whiteness of the *Cardilla* limestone displays every testaceous fragment in strong relief, and enables us to discover that the *Cardilla* is the only bivalve, and that it is accompanied by a *Purpuroidea*, and more sparingly by three large *Naticæ*, all of which probably constituted checks upon its superabundance. *Monotis radiata* occurs by myriads immediately beneath the planking bed on Minchinhampton Common, and the gregarious habits of *Perna mytiloides* may often be shown in a small hand specimen of rock. *Cardium Beaumonti*, Archiac, is found only in the upper beds, where, in abundance, they rival the *Perna mytiloides*, of the lower series. In spots where the rock becomes a barren sandstone far away from all detritus of shells, and probably deposited at greater depths, a cluster of *Pholadomya concentrica* or *P. Murchisonia* sometimes appears; nor are any shells of the genus *Pholadomya* ever found in the shelly beds of the Great Oolite; they are likewise absent in the Fimbria bed of the Inferior Oolite, and it may be safely predicted, that they never will be found in the shelly roe-stone of the vicinity of Cheltenham; these beds were evidently deposited in a shallow sea, and portions of them even possess a littoral character. The little knowledge we possess of the habits of the recent *Pholadomya candida* is in exact accordance with this fact. At one locality the upper beds have produced a dense colony of *Terebratula media* to the exclusion of all other shells. *Lucina lyrata*, *Pholadomya truncata*, *P. nana*, *Ceromya excentrica*, and *Ceromya semistriata* are likewise never found isolated.

The changes of external characters produced by growth alone form another interesting subject for study, and have occasionally become a source of error and confusion. Two examples will sufficiently illustrate this. The large and elegant new species of *Lima* (*L. varians*) has a

surface when young covered with beautifully large waved striæ; a good series will show the gradual disappearance of these until a mere remnant is seen on the anterior border; the figure becomes more gibbose and elongated, and finally is devoid of all markings, except the concentric lines of growth. It is found in the the shelly Great Oolite and Fimbria bed of the Inferior Oolite. *Macrodon Hirsonensis* is another example. Phillips, in his "Geology of Yorkshire," gives two shells the name of *Cucullaea elongata*, one of which, t. 11. f. 43, is our species in its young state, with regular longitudinal striæ. A broken specimen with striæ more irregular, but still in its young state, is the *Cucullaea rudis* of the "Mineral Conchology," t. 447. Another variety of figure, more advanced in age, is the *Arca elongata* of Goldfuss, t. 123. f. 9. *Cucullaea Hirsonensis*, Archiac, t. 27. f. 5, is a half-grown specimen with the longitudinal striæ obliterated. The genus is described in Mr. Buckman's "Geology of Cheltenham," but the species there figured seems to be distinct from the one in question. Our species is abundant in the planking beds, but more rare in the Fimbria and Freestone beds of the Inferior Oolite. To pursue the subject further would involve descriptions of individual species useful only in a monograph devoted to the purpose. Here these remarks may fitly conclude with the expression of a hope that the large number of our Great Oolite shells new to science may ere long be given to the public*, and that the fossil fauna of the Cotswolds generally may by the instrumentality of this Club acquire a "local habitation and a name." Probably no district in England contains an equal number of fossil treasures which have not as yet been transferred to the plate of the engraver.

* Perhaps by means of the Paleontographical Society.

Address to the Cotswold Naturalists' Club, Read at the Winter Meeting, January 22, 1850. By Sir THOMAS TANCRED, Bart.

GENTLEMEN,

I FEEL that I owe an apology to the Club for assuming one of the duties of our excellent President, Mr. Baker, by delivering the Annual Address at this meeting; my excuse, however, must be, that I act by command of my superior officer, who pleads that as he has been doing duty as Secretary for most part of the past season, the Secretary should take his place on the present occasion. I will therefore avail myself of the wholly irregular position in which I am placed, to pay a tribute to the merits of the happy freedom from the restraints of rigid laws, and the absence of restrictions in which, as a body, we glory. I believe it is an important principle in the success of our prototype, the Berwickshire Club, that the occasional meetings of those of congenial tastes, for the purpose of enjoying agreeable converse amidst scenes of interest and beauty, are not hampered by pedantic rules, the infliction of fines, or any compulsory regulations beyond those which good feeling and a desire to promote harmony and mutual enjoyment will dictate. Having no property, like a light-armed corps of irregulars, we can meet and disperse without the *impedimenta* by which the movements of more regular bodies are obstructed.

As our Annual Address is chiefly a recapitulation of the meetings of the past season, I am gratified (after a perusal of the notes with which our President has in my absence enlivened our minute-book) to be able to congratulate the now numerous members of our Club on our present healthy and prosperous condition, after the close of our fourth summer. Our meetings have by no means fallen off in the interest of the scenes to which they have conducted us. We measure our success more by the agreeable meetings and intercourse between persons of congenial

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tastes which our Club promotes, and by the enjoyment to which it leads of those scenes, which Providence has so skilfully adapted to call forth in us an admiration of His works, rather than by the absolute amount of new facts or discoveries which we may in the course of our rambles together, or of our solitary studies, contribute to the stores of science. Some papers towards the next number of our Transactions have been furnished during the past season; but our meetings have been, as they are intended to be, more fruitful of improvement and entertainment to ourselves, than of what concerns the public.

With these introductory remarks I resume the chronicle of our proceedings from the last meeting of the season of 1848, to which it was brought down in the address of our President last year.

Our winter meeting in 1849 was held at Gloucester, on January 18th, to enable us to take advantage of the kind invitation of the Literary and Scientific Association of that City, to join their *Conversazione* on that evening. Our meeting was attended by Messrs. Light, Baker, Strickland, Bayly, Knollys, Rumsey, Gyde, Hayward, Ball, Wood, Jones, and Sir Thomas Tancred, members, and by Mr. Gould (the Australian naturalist), Waldren, Todd and North, as visitors. We saw with great interest at the house of our member, Mr. Wilton, his living specimens (some of them hatched in this country) of that beautiful little Australian Parrot, the *Melopsittacus undulatus* of Gould. This naturalist, who had first brought this species alive to Europe, and described and figured it in his magnificent work on the Birds of Australia, was fortunately with us, and was much interested with the account Mrs. Wilton gave of the habits of this bird, which she had had such a favourable opportunity of observing. We witnessed the anxiety of the cock bird to keep his mate, which was then sitting on three eggs, to her maternal duties. Whenever she left the nest for a little exercise, he appeared in great excitement and soon began to drive her back; indeed we were told that when she first began to sit, domestic broils had run so high, that the hen was severely injured by her ungallant consort; he was, however, in return, very assiduous in supplying her with food as long as she remained on the nest.

The cathedral,—a dormitory of a convent of black friars,—and

the docks with the numerous vessels from all parts of the world unloading grain of all sorts, in one of which we found a very pretty Lyre Antelope from Africa, and other curiosities, occupied us till dinner, after which our President read—not a message like those giants of transatlantic fame—but an address to the full as interesting to us—detailing the origin and progress of our Society. Mr. Gyde also read a very interesting paper, for which he had been awarded the prize of the Society of Arts, upon methods of preserving paper and parchment from mildew. The rest of the business of the Club was then transacted, and we adjourned to the *Conversazione*, which occupied the rest of the night.

May 8 found us assembled in great force, resolved to begin the season well, at Swindon station, there being present, Messrs. Baker, Light, Bolland, Barker, Daubeny, Bayly, E. and D. Bowly, Stronge, Phelps, Strickland, Buckman, Jones, Powell, Streeton, Prower, Taylor, Dr. Daubeny, and Sir Thomas Tancred, members—Mr. Story Maskelyne, Mr. Holland, Rev. E. Meyrick, and Mr. Moore, favouring us with their company as guests. Mr. Light and Mr. Streeton, whose loss, alas! we have had since to deplore, had kindly engaged vehicles, besides furnishing their own, to take us to the remarkable Druidical remains at Abury. On our way a party of us accompanied Mr. Maskelyne to Basset Down House, his father's property, where he has made a very interesting geological and chemical discovery, viz. the existence of a thin bed of phosphate of lime nodules in the upper green sand at its junction with the chalk marl, in the same position and of the same character as those which have excited so much interest in the neighbourhood of Farnham, but which had not been previously discovered on this northern flank of the chalk range. The lower bed of the same, in the lower green sand, has not yet been observed. Abury, Silbury Hill, the Serpent, and the circles of Druidical stones enclosed by an extensive foss and dyke, were examined with great interest, and by stationing the members of the Club in the spots whence many of the stones had been removed and destroyed, we restored for the moment the form of the smaller circles. Mr. Strickland mentioned his having been on the top of the largest artificial mound, like that of Silbury Hill, which is known, viz. that called the Tomb of Halyattes in Asia Minor, described by Herodotus.

After dinner Mr. Buckman gave us an account of a species of fungus (*Agaricus Prunulus*), a dish of which we had eaten at breakfast, and which forms the "fairy rings" on the grass field in front of the Royal Agricultural College. By means of an accurate plan of these rings, executed by the Teacher of Surveying at the College, he hopes to be able to determine precisely the changes which may occur in the shape and size of the circles and their rate of increase. Mr. Strickland explained the process of Papyrography or Anastatic printing, which is applicable to the cheap production of many sorts of drawings of objects of natural history.

Some specimens of popular meteorology or prognostics of the seasons were related by the Rev. E. Meyrick, couched in the following rhymes. One points out the season for sowing barley:—

When the elmen leaf is as big as a mouse's ear,
Then to sow barley never fear;
When the elmen leaf is as big as an ox's eye,
Then says I to my boys, hie, boys! hie!

Another gives a prognostic of a mild winter:—

D'if before Martin-mas
The ice will bear a duck,
The rest of the winter
Will be as wet as muck.

To these we may add a Kentish adage:—

If you have grass in Janivere,
You'll have no more the rest of the year.

The second meeting for last season took place on June 26th, for the events of which, and of the subsequent ones, I am indebted to the graphic notes of our President. The following party sat down to breakfast at the *Bell* at Gloucester: Messrs. Ball, Barker, Jones, Phelps, Rumsey, Strickland, Wilton, Baker, and Dr. Daubeney, members, and Dr. Evans, the Rev. — Stackpool and Mr. H. Clifford as friends. A portion of these gentlemen after breakfast proceeded in a break under the conduct of our President towards May Hill, performing a journey which sounds, when described in scientific language, rather formidable, for Mr. Baker says that "he succeeded in driving the party down the lias escarpment at High-wood, across the new red marl to

Huntley, and then up the Silurian rocks to Little London." Following the Wenlock limestone from this place they reached the Caradoc sandstone, the oldest formation in this district, on the summit of May Hill. The elevation of this summit remains yet to be determined by the Club, as a mercurial thermometer which had been brought by one of the party was out of order, and an aneroid one, which was being carried up the hill, "ere we reached the summit," says Mr. Baker, "was observed to fall—not by degrees (as was expected), but in a most unexpected manner—plump from a handkerchief to the ground." From the top of May Hill a most perfect panorama was exhibited to the Club. Northwards the sienite ridge of the Malverns forested into a cluster of volcanic cones. On their left the Abberley Hills, and beyond them again the Cleve Hills in Shropshire. To the westward, looking across the Wenlock and Ludlow deposits, and the old red sandstone in the valley,—whose enormous thickness is proved by the fact, that for a breadth of two miles it is raised at an angle of 50° ,—are seen the Dean Forest Hills, consisting of carboniferous limestone and the coal-measures; and in the far distance the South Wales coal-field and the old red sandstone of the Black Mountains. Across the Severn, looking over the rich vale of Berkeley, with the higher ground of Tortworth, lay the low oolitic escarpment of the Cotswolds from Badminton to Bristol. Stinchcombe Hill was seen advanced far in front of the main line; Cam Down at the mouth of the Dursley and Uley valley; and Selsly Hill guarding the widely ramified Stroud valley; Painswick Beacon towering over the rest. Robin Hood, Churchdown, Cleve and Bredon Hills carry the eye to where the Broomsgrove Lickey is almost lost behind the east shoulder of the Malverns, and thus is completed a more perfect panorama, whether to the geologist or the mere lover of scenery, than is to be found elsewhere perhaps in the south of England.

On their way down May Hill the party encountered a peculiar kind of quaking bog covered with a crust of clay, bearing scanty grass, sufficiently dry to crack on the surface to an inch or so in depth, yet sufficiently elastic to form regular waves when any one stepped on it, over a surface of seven or eight yards: sheep and even cattle grazed on these bogs in safety; but a boy

said that he had seen several horses in them, and that they were sometimes! got out alive. The geologists of the party made some superficial observations on them; only one going thoroughly into the subject, which he did as far as the knee, and found that the substratum consisted of a whitish clay a little thicker than pea-soup. For this discovery an unanimous vote of thanks was given him. At this meeting the Rev. Edwin Meyrick and Nevil Story Maskelyne, Esq. were elected members.

The third meeting on August 7th, to inspect Bredon Hill, promised a large field of interest, and Mr. Strickland had taken much pains to point out the easiest way of reaching the several points of the route, and had moreover invited those who might attend to breakfast; yet, *proh pudor!* the distance and unfavourable weather deterred all but two members, Mr. Baker and the Rev. F. Bayly, from availing themselves of his hospitality. Dr. White joined the party afterwards; and Mr. Strickland, sen., Mr. Hyett, the Rev. Mr. Davies and Dr. Willis were the rest of the party.

Mr. Strickland's rich collection of about 3000 specimens of birds, and the Abbey Church of Tewkesbury, which was undergoing restoration, occupied the party till the inexorable train commanded their departure for the Eckington station, near which, at the ancient seat of Woolashill, a luncheon was most hospitably provided, and the ascent of the Bredon Hill commenced. Mr. Strickland pointed out on the eastern face the inferior lias reaching far above Woolashill, where, at a comparatively short distance from the top, the marlstone crops out, forming a hard shelf between the upper and lower lias. The latter, eaten away into bays and promontories by the ancient sea, forms a nearly perpendicular bank now clothed with coppice, on the top of which the upper lias having been washed off the marlstone, there remains a broad flat shelf which can be traced almost uninterruptedly along the face of the hill. The glorious view from the top was veiled by rain and mists. This unpropitious day did not prevent the select party after dinner from enjoying an animated discussion on philological subjects, Mr. Jones maintaining that not only the Saxon and Latin, but the Celtic and Sanscrit languages were derivable from the same roots. Greek metres and pronunciation were then introduced:

Mr. Strickland (alluding to the fact that modern Greek is invariably pronounced according to the accent) threw out the idea, that the ancient Greeks may in conversation and in reading prose have pronounced the language much as the moderns do; whilst in reading poetry they may have adhered strictly to the poetical quantities, as we, for instance, pronounce the word "wind" differently in prose and poetry. Mr. Strickland furnished a few lines which he had translated from the commencement of the Iliad almost literally into English hexameters, observing correctly the rules of prosody; and Mr. Hyett has since contributed hexameters and pentameters. "In such interesting discourse is the President to be blamed" (Mr. Baker asks), "that he did not break off the conversation with the question, Has any Member a paper to read to the Club, when the probability was that it would be followed only by an awkward pause? How could the President divine that in Mr. Strickland's pocket lay all this time the strata of Leckhampton Hill waiting to be unrolled on the table of the *Royal Oak*?"

This valuable paper, however, has since been read to the Club, and will, I trust, appear in the next number of our Transactions.

The fourth and last meeting of the season took place on September 27th, at Newport, to which place Mr. Baker drove a party from Hardwicke. The members at breakfast were, Messrs. Bolland, Barker, Buckman, Baker, Hayward, Knollys and Phelps, with Mr. Hyett, Mr. Adams Hyett and Mr. Saunderson as visitors. The party proceeded to Whitfield, from whence Mr. Morton, jun. admitted them to Lord Ducie's, Cromhall Park, near a small encampment called Bloody Acre, forming one of the chain of Roman forts running along the Cotswold Hills, and overlooking the great lake in the park. Thence they descended through the remains of a vineyard, consisting of a succession of terraces each about a foot high. It is not known what was the character of the wine grown here. The road presents many points of great beauty, and were the trees opened to allow a view of the bold rocks opposite, the scene would be still more improved. Crossing the head of the lake, the party ascended Anchor Hill, as it is called, or as Atkyns corrects the name, "Anchoret Hill," "where," he says, "are the ruins of a cell,

the anchoret of which was consulted by the monks of Bangor when they went to meet St. Augustine the monk."

Thence passing by the spot where Lord Ducie is commencing a magnificent house in a noble situation, overlooking the lower end of the lake, and by Tortworth Lodge, they found in a marshy piece of ground the somewhat rare *Molinia caerulea*, the only English grass with a solid stem, and also a beech measuring at four feet from the ground 14 feet 9 inches. Thence they reached Tortworth House, passing on the way a remarkable piece of basalt, thrown up suddenly in the midst of a grass field;—Lord Fitzhardinge's keeper being observed to show no slight horror at the word *trap* which he heard frequently uttered by some of the party. Here the remarkable chestnut tree, mentioned in Domesday book as "the Old Chestnut," 19 yards in circumference, delayed them some time, as well as some fine specimens of newly introduced pines. The noble proprietor, however, held out the strongest inducement to a halt in the shape of an excellent luncheon, of which he most kindly invited all to partake, and at which the charms of the curaçoa seem to have made a deep impression on the members who were fortunate enough to enjoy it; and then rode with them to show his stock, scarcely to be equalled in the kingdom, and from the diffusion of which, by means of the annual sales, so much improvement has been introduced in the breed of cattle in this country generally. Michaelwood Chase, with its gnarled oaks, wild thickets, and marshy plains, through which they were guided or watched by one of Lord Fitzhardinge's keepers, afforded a fine field for botanizing, and brought them back to Newport, well-disposed for a good dinner notwithstanding Tortworth. An account of this day's excursion, with graphic illustrations of the incidents of flood and field, has been furnished by Mr. Knollys, which must be preserved in the minute-book of the Club.

Mr. Buckman exhibited after dinner tracings of the Tessellated pavements recently discovered at Cirencester, particularly a head of Ceres crowned with ears of corn, which, after being covered in darkness for so many centuries, our President describes as "starting in horror at the advances of free trade." Mr. Strickland's paper on Leckhampton Hill was read, and also Mr.

Hyett's notes of the heights of many points of the Cotswold Hills determined by the aneroid barometer, which latter is included in the present number of our Transactions.

William Vernon Guise, Esq. of Elmore Court, and William Henry Hyett, Esq. of Painswick House, were proposed and seconded as Members; and this concluded one of the most interesting and successful meetings of the many which the Club have enjoyed together.

Like all bodies, and even these corporeal frames of ours, we have suffered the loss of some elements, whilst others have been added to the Club, during the past year.

Mr. Thomas Niblet being abroad, and Mr. Hamilton having removed from the district, have expressed their desire to withdraw their names; whilst we have to lament the loss by death of the Rev. Mr. Streeton and of Mr. Meyrick of Cirencester. On the other hand, we have added to our body the Rev. Peter Bellinger Brodie, Mr. Nevil Story Maskelyne, and the Rev. Edwin Meyrick.

With this account of our proceedings, at which I have been prevented from being present so frequently as I hope to be allowed to be another year, I bid you adieu, trusting that, though the world at large may be but little the wiser for our proceedings, we may have found, and shall ever find, ourselves wiser and better for our meetings, and always realize the saying of our great poet, by finding "books in the running brooks," "sermons in stones, and good in every thing."

Heights of some points of the Cotswold Hills, with some experiments with the Aneroid Barometer. By W. HENRY HYETT, Esq., F.R.S.

READ 27TH SEPTEMBER 1849.

A FEW months ago, in a formal Report, an Inspector under the Board of Health stated that "Cheltenham has been estimated to stand 200 ft. above the level of the sea, and the height of the Cotswold Hills above the same level is about 300 ft.:"—he meant probably to say "above the level of Cheltenham;" thus making the absolute height of these hills 500 feet above the sea—still an estimate rather wide of the mark when given under the nose of Cleve Cloud, which exceeds 1000.

It is true the case required no accuracy, but such a degree of inaccuracy could scarcely have appeared had a more general knowledge of the truth prevailed in this part of the country. Indeed it has been for years matter of complaint that even the relative heights of the several remarkable points of our Cotswolds were unknown—Painswick, Birdlip, Leckhampton and Cleve Cloud each having their respective champions, but with no authority to quote, nor umpire to determine between them.

Having consulted some of the scientific Members of the Cotswold Club on the point without success, I ventured to suggest that they at least should try to set it at rest. The coincidence of the present Ordnance Survey for the improvement of the river Severn, having their signal staffs actually standing on the very eminences in question, offered an opportunity not to be lost of having measurements made.

I therefore proposed to our excellent President to get (as best I could) a list of the heights of those hills from which we derive our name, and which in the course of our excursions we so frequently climb;—a subject of peculiar interest therefore to ourselves, and not without importance to all who study the geology, botany, &c. of this range. Immediately on receiving his concurrence I wrote to Capt. Yolland, R.E., who has the mapping department of the Ordnance under his direction, and the command of the parties now executing the survey of the Severn. Observing that the signal staffs of their present Trigonometrical Survey afforded the easy means of taking the vertical as well as the horizontal angles, and of acquiring all the information which the public needed, I ventured to express a hope to that officer that he would afford it.

In reply he promised to communicate the information re-

quested, and has since most obligingly supplied the approximate heights above the mean level of the sea of sixteen remarkable points in our vicinity which I shall presently read to you, together with other data which I have myself obtained by the aid of the aneroid barometer lately invented in France, and much vaunted as applicable to the measurements of heights. I then procured one of these instruments from Dent, with his pamphlet upon it, and will now give the results of its comparison with the measurements received from Capt. Yolland.

It may be as well however first to make a few remarks on this new instrument, with a view to show how far it may be applicable in its present state to the purpose of measuring altitudes. It is probably known to most of you, that in carrying a mercurial barometer to the top of a high mountain, the mercury sinks from two causes, the one purely barometric, the other thermometric. Whilst for every 850 feet of perpendicular ascent the weight of the air decreases so as to show a fall, in its counterpoise the quicksilver, of about an inch—for every 300 feet of ascent there is also a decrease in the temperature of 1° Fahrenheit, occasioning a proportional contraction in the quicksilver in the tube, making it stand so much lower than it ought to do were its descent due to the diminished pressure of the air alone. To calculate therefore correctly the height indicated by the mercurial barometer, allowance is always made for decreasing temperature, and tables have been compiled for this purpose from the known rate at which mercury contracts by cold.

The same double effect is doubtless produced in the aneroid barometer, which Mr. Dent says is compensated by means of gas in the "vacuum-vase" of the instrument. This however is, I believe, a mistake*.

In its present form, then, I conclude that a correction for temperature is needed for the exact measurement of heights. There are also two palpable defects, one of which is that the hand or index is frequently so far from the face of the dial, that its parallax leads to error in reading off the scale, which may easily amount to 20 feet in height. This however may be somewhat corrected by bending the hand so as to make it nearly touch the face of the dial. The other fault is that the inch is subdivided into only forty parts, one of which corresponds to 22 feet in height. It would be better to have it graduated to hundredths—so that the actual reading off should tally at once with the barometric tables now in use—or if the size of the dial will not admit of this, to subdivide the inch into fifty instead of forty parts,

* I have since ascertained it to be one. M. Vidi himself informed me in November last, that although he at one time made some experiments on the use of gas in the "vacuum vase"—he has now rejected it altogether.

so that each division should be $\cdot 02$ of an inch. At present, in order to use the tables, it is necessary in reading off to change the vulgar fractions into decimals, which, in jotting down, frequently leads to troublesome mistakes.

It is full time however to come to the table which I promised of the

*Approximate altitudes above the mean level of the Sea supplied
by Capt. Yolland, R.E.*

	By Ordnance Survey. feet.	By Aneroid Barometer. feet.	Difference by Aneroid. feet.
Tewkesbury Church, surface of ground ...	47		
Gloucester Cathedral, surface of ground ...	56		
Barrow Hill, surface of ground	198		
Corse Hill	292		
Christ Church tower, Cheltenham (top)...	343		
Robin's Wood Hill	652	634·2	-17·8
Standish Hill.....	715	691·4	-23·6
Stinchcombe Hill	725	740·27	+15·27
Finger-post on top of Frocester Hill .....	.....	780	
Oxenton Hill.....	733		
Firs at Symond's Hall .....	.....	810	
Uley Hill	823	825·5	+2·5
Painawick Hill	929	935·9	+6·9
May Hill	966		
Birdlip Hill	969	960·5	-8·5
Leckhampton Hill	978	969·9	-8·1
Base of Bredon Hill tower	979		
Cleeve Hill or Cleeve Cloud	1081	1066·8	-14·2
Malvern	1396		

With the exception of Standish and Robin's Wood Hills, the height of each of which is the result of a single observation with the aneroid, the agreement of its indications with those of the Ordnance determinations is very remarkable, considering the errors to which the present construction of that instrument render it liable. I must observe, however, that they are brought nearer to the trigonometrical measurements by my having rejected some of my first attempts, in which I am almost certain that I made mistakes, and by subsequently adopting the mean of two or three observations, a process which always reduces the extremes of error. Thus for Painswick Hill I had three observations—

One giving it . . . 919 feet.

Another . . . 934·8 „

The third . . . 954 „

giving a mean result of 935·9 feet, which differs only 6·9 feet from Capt. Yolland's figures.

I am sorry that I have not had time to try more of our heights ; but I thought it better to repeat the observations on the same hills in order to obtain mean results, and thus to sift my own probable errors, than to persevere in them undetected.

Throwing out of consideration, then, some of my first trials, before I was quite up to the use of the instrument and its tables, the results which I have just given are highly satisfactory. But on the other hand I tried it against the published sections of the Cheltenham and Great Western Railway with less success, as the following comparison will show :—

	By Company's sections. feet.	By Aneroid. feet.	Error. feet.
Stroud station above Gloucester station	116·3	124·75	+8·45
Summit-level at top of Saperton tunnel above Gloucester	352·2	413·7	+61·5

Now these were the means of two trials; in the latter case the discrepancy is greater than I can easily explain, unless the oscillations of the railway carriage have any effect on the instrument, which I can hardly suspect; for in all other cases, however carefully carried, it must have been exposed to rough shaking*. On the whole therefore I must suspend my opinion as to the merits of the aneroid for measuring heights till after further experiments, and at any rate would recommend the improvements in the construction, to which I have before alluded, to be effected, viz. the decimal graduation to be adopted, and the index to be placed closer to the face of the instrument.

P.S. Since the compilation of the above paper I have been fortunate enough, on a visit to Paris, to make the acquaintance of the ingenious inventor of the aneroid—which I find, in its present state, he regards as a domestic rather than a scientific instrument,—an estimate of its capabilities in which its continued use leads me very much to concur. Still, while I find it perfectly well adapted to the house purposes of a common weather-glass, I can say no less of it as an instrument for taking heights, than that it is far more commodious and much less likely to get out of order than a mercurial barometer—and when limited, as my trials were, to heights not exceeding 1200 feet, that it exhibits quite sufficient accuracy for general purposes—a power which I have no doubt in its present form may be extended to heights of some 2500, and were the index graduated to 24 or 25 inches of the mercurial barometer, probably to the height of any hills in Great Britain.

M. Vidi, however, has made some elaborate trials towards a more purely scientific instrument. If he persevere, I have no doubt he will succeed.

The grand Exhibition of Works of Art in London in 1851, offers him a good opportunity for submitting his invention to more general notice,—and, to the judges perhaps, a not inappropriate object for a premium.—W. H. H.

* The error may be this—that the Company's sections were published before the completion of their line, which was eventually carried at a rather higher level than these sections show.

On Trichites, a fossil genus of Bivalve Mollusks.

By JOHN LYCETT, Esq.

READ 22ND JANUARY 1850.

THIS generic form is distributed over an extensive area both in this country and upon the continent; it occurs in more than one of the oolitic formations; the Cotteswold Hills more especially produce it abundantly; nevertheless it is almost entirely absent from the cabinets of English collectors; and if we examine that section of modern literature which professes to illustrate fossil conchology, our search will scarcely be more successful or satisfactory. In both cases the defect may be accounted for by a difficulty almost insurmountable experienced in obtaining illustrative specimens in a condition perfect, or even approaching to perfect; fragments indeed are easily detached, but these alone do not convey any precise or adequate idea of the generic characters.

The shells are large, the very Titans of their period, sometimes extending to upwards of a yard across, of a thickness far surpassing that of bivalves generally, but of a structure peculiarly fragile (prismatic crystalline), consisting of fibres closely arranged, placed perpendicularly to the surface and breaking readily in the direction of the fibres with any slight concussion; this is a serious obstacle to their separation, to which may be added, that the upper ragstone bed of the Inferior Oolite in which they most commonly occur is very hard and intractable in the nature of its fracture. In almost every open quarry of this rock, and more especially in the stratum called Trigonia grit, these thick fibrous masses may be noticed; more rarely also in the middle portion of the same formation and in the shelly beds of the Great Oolite. They have usually been referred to a gigantic species of *Pinna*, probably from a similarity of structure. The Cotteswolds have produced two species, which are distinct from another recorded from the Jura which will subsequently be noticed. Dr. Plott, the historian of Oxfordshire, appears to have been the first person who applied the term *Trichites* to these shells. Woodward, in his 'Catalogue of English Fossils,' 1725, part 2. p. 101, 102, 'De testis aliisque incerti generis,' mentions that Lhwyd sent a specimen of this genus from the Oolite of Bullington Green near Oxford, with the title "*Trichites Plottii*, Hist. Oxon. Veneris crines forsan Plinio," and adds the caustic remark, that these two writers, Dr. Plott of mere simplicity, and Lhwyd of design, "darken

counsel by words without knowledge," Job. xxxviii. 2; he also records fragments in his collection from Risington and Birdlip Hill in Gloucestershire. The generic name was of course derived from its capillary or hair-like structure. Far from joining in the foregoing censure, we are rather disposed to respect the discrimination which recognized this obscure generic form in the earliest infancy of conchology. It was observed by Saussure in the Coralline Oolite of Mount Salève near Geneva, and described by Deluc in the first volume of the great work of Saussure on the Alps, p. 192, and figured in part 2. fig. 5, 6. This eminent naturalist ascertained some of the general features of the genus; the great thickness of the test, its fibrous structure, analogous, he observed, to that of *Pinna*, and its inequivalve form; this latter character, he observed, compelled a generic separation, and he proposed to call it *Pinnegene*. Deluc seems to have been unacquainted with the prior claim of Lhwyd. Guettard and De-france observed it in the oolitic rocks of Normandy; they regarded it as a distinct genus, but do not appear to have contributed anything material to its elucidation. The latter author's views are contained in an article contributed by him to the 'Dictionnaire des Sciences Naturelles,' tom. lv. 1828.

Deshayes, in his last edition of Lamarck's Conchology, does not recognize its generic value, but describes Deluc's species (tom. vii. p. 68) under the designation *Pinna Saussurei*; the materials at his disposal seem to have been very imperfect, and in consequence his description is incomplete and calculated to give an erroneous idea of its characteristic features. The term 'subæquivalvis' for instance does not accord with Deluc's figures; it is stated to gape posteriorly, which, judging from our specimens, must be an error; the character of the terminal extremity and interior of the hinge-line are not mentioned. The only other recent notice of the genus which we have discovered is contained in the volume of Dr. Pictet, which is devoted to fossil conchology, where the figures of Deluc are copied on a reduced scale, but no additional information is given. From the absence of all notice of the genus by the leading systematic writers on conchology, it may be concluded that they did not recognize the distinction of Deluc's shell from *Pinna*, or having no personal knowledge of the form, they hesitated to allow it a place with recognized genera. It has therefore hitherto existed almost on the horizon of science as an obscure and problematical object, which it will be our present endeavour to bring more nearly within the grasp of the conchologist.

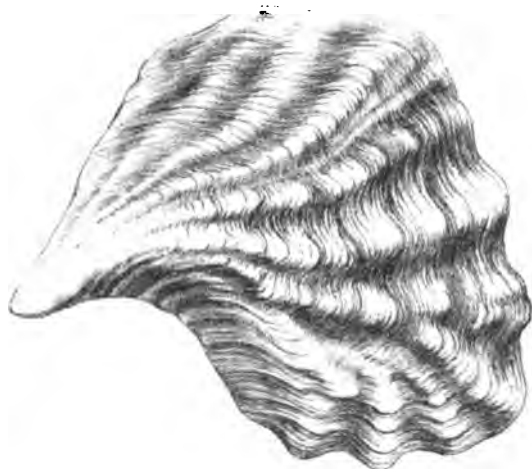
Generic Character.

Shell of fibrous structure, thick, ovate, oblong, inequivalve, inequilateral and irregular; umbones terminal, produced and

funnel-shaped, the apex gaping. Hinge-margin oblique and elongated, the margins undulated, anterior margin corrugated and thickened beneath the umbones. Hinge lateral, linear and without teeth.

Our specimens, though not numerous, exemplify the genus in a satisfactory manner, and place its characters free from ambiguity. The valves are both separated and in apposition; in one instance the interior of the cardinal border and terminal extremity have been cleared, but the muscular impressions have not been seen. The general figure is oblique and nearly quadrilateral, one valve being convex, the other flattened or even a little concave; the margins undulate, are rather irregular, including even the hinge-line, and there is always a considerable undulation occupying the posterior border, at which part the valves are thinner, more expanded and flattened; the undulations of both valves correspond; they are rounded, having no posterior truncation, and when closed leave no hiatus. In the concavity of the anterior border is a corrugation which marks the probable place of exit for a byssus, a feature exactly corresponding with that in *Perna*, *Avicula*, &c., but there is scarcely any distinct hiatus perceptible. The umbones form a hollow funnel-shaped cavity narrowing to the extremity, but open, the opening being rounded, and formed by the termination of both the valves; the shell about its middle and anterior parts attains a thickness exceeding any recent bivalve, and comparable only with the fossil genus *Catillus*; the smaller valve is the thinnest. With respect to its affinities, that to *Pinna*, which has engaged the attention of naturalists, would appear, to say the least of it, to be very remote. What do we find in conformity with a delicate, almost papyraceous shell, straight, equivalve and regular, with a truncated, widely gaping posterior extremity? Absolutely nothing; on the contrary we have a shell of monstrous thickness, very oblique, inequivalve and irregular, its posterior side being neither truncated nor gaping—in fact nearly every generic feature of importance is reversed; the fibrous structure common to both seems to have misled observers into a supposed generic identity. But even the structure of the two genera when carefully examined presents a difference equally marked and characteristic: the strength of the thin and delicate *Pinna* is produced by a double structure, by its substance consisting of two layers, the outer being fibrous, the fibres placed perpendicular to the surface as in *Trichites*; but the inner one is nacreous or lamellar, a contrivance which effectually obviates the fragility which pertains to the fibrous structure. *Trichites* on the contrary has one structure throughout; the perpendicular fibres are crossed by a few extremely fine parallel laminæ, which do not break off the continuity of the fibres, and impede fracture only to a very limited extent. The

Plate 1.



-Lyall del.

Modelo. From J. Wallington J. S. S. S.

J. De C. Sowerby, in lap. del.
Digitized by Google

genus *Catillus*, found only in the cretaceous rocks, is that which seems to approximate most nearly to the present form. Both have very much the same general figure, fibrous structure and thick substance; on the other hand, the *Catilli* are nearly equivalve and regular, the hinge consists internally of a linear series of crenulations, and the terminal character of the umbones is likewise distinct.

The position of *Trichites* in the conchological series should therefore be near to *Catillus*; its irregularity is such that no two of our specimens are exactly alike either in outline, convexity or surface. Two individuals were nearly covered with small adherent shells, a sufficient indication that their habits were sedentary or sluggish. The great fragility is certainly not the effect of fossilization, but a consequence of its structure, and must always have existed; the condition in which the shells are found presents a sufficient confirmation of this idea. After frequent and persevering, but for the most part fruitless exertions with the hammer and chisel, we are enabled to state that *Trichites* usually occurs in the state of distinct portions or fragments, and that entire individuals are rare; the fracture too not unfrequently is found across the thickest part of the test. A mollusk, whose shell was thus constituted, could scarcely have been the denizen of a shelly beach within the influence of the tide, or exposed to frequent rolling and collisions with other fragmentary bodies; its habitat must have been tranquil, and probably covered deeply and defended by soft mud or sand. Specimens which occur in the chaotic shelly beds of the Great Oolite, locally termed 'planking,' may be regarded as travelled, and, as might be anticipated, are usually in portions only, and these seldom large; individuals perfect or approaching to perfect are the exceptions to the rule. In the upper portion of the Inferior Oolite the conditions of sea-bottom appear to have been somewhat different; there is an absence of shelly detritus; the valves of the Conchifera are most frequently in apposition, and *Trichites*, as far as can be ascertained, appears more frequently to approach to the perfect condition.

EXAMPLE.

Trichites nodosus. Plate I.

(Great and Inferior Oolite.)

Shell quadrately curved, with longitudinal waved nodose ribs; ribs few, diverging, some bifid. The larger valve convex, the lesser rather concave, with nodules nearly obsolete, disposed in two concentric series.

Our specimens differ much in the degree of convexity and character of the ribs, the latter being occasionally scarcely distin-

guishable; the terminal umbones are very much curved and turned forwards. The planking beds of the Great Oolite at Minchinhampton Common and freestone of the Inferior Oolite near to the same locality produce it, but it has not been recognized in the upper portion of the Inferior Oolite; from the intractable character of that rock, however, this circumstance must not be considered as conclusive of its absence. Our examples in point of size convey but a very inadequate notion of the magnitude often attained by the genus; but it would appear that the larger sections belong to the second, or possibly even to a third and more gigantic species. The *Pinna Saussurei* (*Pinnegene* of Deluc) is distinct from our Cotteswold shells; his figures, taken from specimens broken and partly enveloped in the stone, do not convey any precise idea of the external form, but the portion which exhibits the character of the surface is altogether different.

Trichites undatus.

(Inferior Oolite.)

Shell oblong; umbones . . . ; ribs obscure, few, concentric, irregular and undulated, sometimes obsolete in the larger valve.

The smaller valve unknown.

Length 9 inches, breadth $7\frac{1}{2}$ inches.

The only well-preserved example in our possession has lost the terminal extremity, but in other respects is nearly perfect; the hinge-line is more nearly horizontal than in the *T. nodosus*, and the entire form is less convex; the other valve, though attached, cannot be cleared from the hard matrix. It occurs abundantly in the upper ragstone of the Inferior Oolite, a rock which usually defies all attempts to separate the shell in a tolerable condition; in this instance a large portion of the surface fortunately coincided with the natural parting of the bed.

On the Structure and Arrangement of the Tesserae in a Roman pavement discovered at Cirencester in August 1849. By JAMES BUCKMAN, F.L.S., F.G.S.

READ 22ND JANUARY 1850.

THE object of this paper is to point out the nature of the materials of which the party-coloured floors so beautifully wrought in ancient Roman dwellings are composed, as also to offer some remarks upon their principles of arrangement.

The tesserae of Roman pavements may be said to be formed out of two classes of materials, the first of which, consisting of portions of various coloured rocks, may be termed *natural*; the second, of stained or coloured terra cottas and glass, being *artificial*.

The natural tesserae furnish but few colours, and those of a sober cast, hence these will be found forming shadings to figures entering largely into the composition of borders, or filling up the groundworks of the designs. They consist of portions of natural rocks from various localities, those belonging to the district where the pavement is found, as far as I have observed, always contributing their share.

The Cirencester pavement presented the following :—

Colours.

Rocks.

- | | |
|------------------------------|---|
| 1. White, composed of | Hard fine-grained Oolite. |
| 2. Light yellow | Pebbles of the Wiltshire Drift, and Oolite. |
| 3. Gray | The same as No. 1, altered by heat. |
| 4. Slate colour or black ... | Limestone bands of the Lower Lias. |

No. 1 occurs as a bed of compact fine-grained stone of about 2 feet thick in nearly all the freestone quarries of this district, where it is distinguished under the name of the Limestone bed; its geological position is about the middle of the freestone rocks of the Great Oolite; it is well exposed at Trewsbury quarry, at the Acman Street Station, and at the smaller Sapperton tunnel, and was no doubt obtained by the Romans from the quarries once worked by them in the vicinity of the Querns.

2. The tesserae, of a yellowish or nankeen hue, appear to have been made of portions of the pebble-drift with which parts of the neighbourhood of Cirencester is so thickly strewn. Stray pebbles of this may be found in almost every field to the south of the town, whilst at Somerford Kaynes, and other places, it enters largely into the composition of the gravel beds which are

there worked. It is probable that this drift is the debris of that tertiary rock known in Wiltshire as Sarsen stone, of which the huge stones of Abury Camp constitute the more enduring monument.

3. This, though differing so much in colour from No. 1, yet seemed so identical in lithological structure as to induce me to try to ascertain from experiment whether or not they were the same, when, on roasting a portion of the rock No. 1 in the fire for a few minutes, it gradually assumed the colour of the gray tesserae, the change no doubt being due to some alteration in the chemical conditions of the iron with which the stone is slightly charged.

4. The dark colour of the lias entered largely into the composition of these pavements, as much of the outline of the design and the darker bands of the border ornaments are composed of this stone, which, judging from an Ammonite found in one of the tesserae, was obtained from some one of the thin layers of argillaceous limestone with which the clay-beds of the third division of the lower lias in the vale of Gloucester are separated, and no doubt the stone in question was brought from that locality.

The *artificial tesserae* found at Cirencester entered for the most part into the construction of the finer and more important parts of the details of the figures and designs; they consist of—

Colour.	Substance.
1. Black	 Terra cotta or baked clay.
2. Light red	
3. Dark red	
4. Brilliant ruby-red ...	Glass.

1. This is a much darker shade than that of the lias, and was consequently used in those portions of figures where bold relief was required; it seems to be composed of a dark-coloured clay, only slightly, if at all burnt; as the tesserae are very fragile, this would almost lead to the conclusion that these were not artificially coloured but made of a clay containing a large quantity of protoxide of iron, which is black, and they were consequently burnt in smother kilns, or the black would change to red by the protoxide becoming peroxidized. The identity of constitution of these tesserae with black pottery is very apparent.

2 and 3. The two reds are made from clays containing more or less of iron, and perhaps this substance may have been added in these and in the instance above noticed, where it was desirable to deepen the tint; of course the red is due to the peroxidation of the iron salts.

4. In only one medallion of the Cirencester pavements has glass been made to play a part, and that is just when the trans-

parency and brilliancy of colour of this substance were of the utmost importance to the composition.

An examination of the pavement itself will show that the medallion which symbolized Spring, represents a fine female head crowned by what appears a chaplet of olive-green and verdigris-coloured leaves. Now on studying this head attentively, I was surprised at seeing these two colours intermixed apparently in a most inharmonious manner; and as the verdigris-green was so different from any other colour I had met with, it suddenly struck me that it was a mere coating to the tesserae, resulting perhaps from chemical decomposition, and on scraping the surface with a knife I was gratified to find that the verdigris only covered up a glass of an exceedingly rich ruby tint. I then obtained a small portion for a chemical analysis, which was kindly undertaken for me by Dr. Voelcker, the College Professor of Chemistry, the results of which are so interesting that I must beg to lay it before the Club in his own words.

Examination of red-coloured Roman glass (Cirencester).

"The red glass which had undergone a partial decomposition was coated with a white crust, which itself was covered with a green substance. The latter on examination proved to be carbonate of copper; the white crust dissolved with effervescence in nitric acid, leaving gelatinous silicic acid behind, and was found to consist principally of carbonate of lead and silica. The glass, after having been treated with nitric acid and thus been deprived of the white and green coatings, exhibited a bright red colour; it was now transparent, not very hard, and easily flexible when exposed to a moderate heat. On analysis the following substances were detected, as—

Oxide of lead.
Protoxide of copper.
Alumina.

Oxide of iron.
Lime.
Silica.

"The red colour of the glass undoubtedly is due to protoxide of copper, which was present probably in combination with alumina in considerable quantities. It is well known that the ancients were acquainted with the art of colouring glass red by means of copper, for Cooper informs us (*Annales de Chimie*, série 1. tom. lxxiii. p. 20) that he detected in an antique red glass protoxide of copper, and Klaproth likewise ascribes the red colour of an antique glass to the presence of copper, which he considers to be contained in the glass in the state of protoxide. This gentleman found exactly the same constituent parts as those found by me in the Cirencester glass; it has further been ascertained that all the red glass in antique mosaic church windows is

coloured red by copper. Gold, which likewise imparts a beautiful red colour to glass, is never met with in Roman glass, and it appears that the property of gold and its combinations was unknown to the Romans, for we do not find any traces with the ancients which could justify the supposition of their being acquainted with the art of making the purple and rose-coloured or ruby-glass which at present is manufactured in great perfection in Bohemia, where a preparation of gold, generally chloride of gold, is used for that purpose by the glass manufacturer. The application of gold preparations in the preparation of red glass, comparatively speaking, is of recent origin, for it appears that before the 17th century the use of gold preparation for this particular purpose was unknown. In the 17th century we find the first reference made to the use of gold for colouring glass red by Cassius, who discovered and recommended a new combination of gold, which, to the present day, is known under the name of Cassius gold purple.

“Copper thus appears to have been the material with which the ancients were in the habit of colouring glass red. Various methods of applying copper were in use, and though metallic copper is capable of imbuing glass with a red colour, no doubt on account of the protoxide of copper which is found in almost every sample of copper, in most cases it was first subjected to operations which tended to generate protoxide of copper. Frequently also peroxide of copper (black oxide) was used for the same purpose, but in this case the glass mass received an addition of substances, as tartar, charcoal, soot, iron, protoxide of iron, which substances at a red heat combine with part of the oxygen of the black oxide, and thus become the means of reducing the latter to red oxide of copper.

“This important action of iron seems to have been known to the ancients, for both Cooper’s and Klaproth’s analyses of antique red glass referred to above, as well as my own of the Roman glass found in Cirencester, exhibits, besides oxide of copper, oxide of iron. Later the art of colouring glass red by means of copper was lost entirely, and many persons of our days even denied altogether the possibility of producing a red glass with copper. Very generally all red glass was supposed to contain gold.

“The importance of the subject induced the Society of Arts of Berlin to offer a prize for a method of manufacturing red glass by means of copper. The prize was gained by D. Engelhardt of Zinswider, who gave several directions of manufacturing red glass, and who succeeded in making a beautiful red glass with protoxide of copper and without using gold at all.” (*Vide Verhandl. des Gewerbevereins*, Berlin, 1828, S. 15.)

From this analysis it will be seen that the Romans imparted

this red tint to glass by a very ingenious method, and it was the substance used for this purpose, namely copper, which covered over the tesserae as the surface of the glass had become decomposed in the form of a carbonate of that metal.

This fact is curious in its bearing upon the pavement as a work of art; as so harmoniously are the colours arranged in all the figures that it may almost be taken for granted that, as in this instance, when there is an exception in this particular, it is due to some subsequent change having taken place in one or other of the colours. In the case before us our first tracing was coloured with the verdigris-green: it was unsatisfactory; but on making a new tracing and colouring it according to our amended observations, it at once became harmonious in colour, and assumed an intelligible form, though all our colouring will not enable us to convey the idea of ruby-gemmed flowers like the substance used, the transparency of glass contributing much to the general effect.

Sketch of the Geology of the neighbourhood of Grantham, Lincolnshire; and a comparison of the Stonesfield Slate at Collyweston in Northamptonshire with that in the Cotswold Hills. By the Rev. P. B. BRODIE, M.A., F.G.S.

READ 18TH JUNE 1850.

THE object of the present paper is to give a short account of the geology of a portion of the county of Lincoln, especially in the neighbourhood of Grantham and Stamford, and to point out its identity in many respects with certain parts of Gloucestershire. The formations observable in the district above mentioned are the Great Oolite, Stonesfield Slate, and Lias. The Great Oolite (and some of the superior overlying groups, including in places the cornbrash) may be traced with considerable regularity from Minchinhampton in this county in a north-easterly direction to Stamford, whence it pursues a more northern course into Yorkshire. The Great Oolite is extensively quarried at Ketton and other places near Stamford, and affords a good building-stone, more or less full of fossils; one bed, in which I found *Patella rugosa*, consisting of a coarse-grained oolitic freestone lithologically resembling the shelly freestone in the Inferior Oolite at Leckhampton Hill. I was unfortunately so much hurried that I had no time here to make sections, or to examine the quarries more accurately. In a beautiful old Norman church lately restored, at Tickencote in Rutlandshire, I noticed blocks of this stone made up of minute shells in a good state of preservation, similar to some on Minchinhampton Common. Crossing the narrow lias valley to the opposite hill at Collyweston, which commands an extensive view over the surrounding country, the Stonesfield slate is largely quarried, and, as in the Cotswolds, occupies the highest ground in the district. The following is a section of one of the deepest quarries in descending order:—

	ft.	in.
1. Rubble, consisting chiefly of broken slate	5	0
2. Sand, a few inches.		
3. Hard slate (ragstone)	4	0
4. Yellow sand	3	0
5. Slate	1	0
6. Yellow sand	1	0
7. Bluestone, with traces of vegetable matter in fragments ..	1	6
8. Slate	3	0

18 6

Further on some inferior strata are visible, viz. :—		ft. in.
9. Sand	4	0
10. Ferruginous oolite.....	14	0
11. Clay		
Total		36 6

The beds seem to be nearly horizontal.

The best slate splits into thin laminæ, and forms a beautiful and useful material for roofing, preferable even in some respects to that of the Cotswolds, being finer-grained and more micaceous; but the average thickness of the whole is about the same. There is however a sufficient lithological resemblance to identify this formation in Northamptonshire with that of Gloucestershire and Oxfordshire; and even the minor details are more nearly alike than the distance of one deposit from the other would lead us to suppose. The formation, however, near Stamford is by no means so extensive in its geographical range, being, as far as I am aware, limited to a few localities in that neighbourhood. I was unable to trace the junction of the slate with either the Great Oolite above, or the Inferior Oolite below, but it may be observed (according to Mr. Morris) in one or two places in this district. I cannot state positively whether it is as closely connected with the Great Oolite as it is in the Cotswolds, where my friend Professor Buckman and myself (in a joint paper on the Stonesfield Slate of Gloucestershire*) conceive it to be not sufficiently distinguishable from it to entitle it to rank as an independent formation. But from the facts and sections given in Mr. Morris's paper, they seem to be as closely intermingled; indeed he distinctly states that the slate is *not* independent of the Great Oolite, and thus confirms our views respecting its characters in Gloucestershire. The bed of clay, which we suppose to be the representative of the 'Bradford clay,' does not occur at Collyweston overlying the slate, though it may have been previously denuded.

Fossils generally are not very abundant in the Collyweston slate, and these consist almost entirely of marine shells, among which *Trigonia impressa* (a highly characteristic shell), *Gervillia acuta* (a gregarious species, lying grouped together on the slabs, but not common in the Cotswolds), *Cardium*, *Pinna*, *Pecten*, and a small *Natica*, are the most frequent, though a few others are mentioned by Mr. Morris. He also notices numerous fragments of *Pecopteris polypodioides*, a species of fern abundant in the oolitic shales of Yorkshire, which seems to identify the slate with them. Plants however, as far as my observation went, are comparatively rare at Collyweston, and very imperfect. I walked over tons of slate laid out for weathering, as in Gloucestershire, and I could not observe even a trace of vegetable matter, the slate being in most cases particularly unfossiliferous, and on this

* See Quarterly Journal of the Geological Society, No. II. p. 220.

account much better adapted for æconomical purposes. Two genera of plants only are mentioned by Mr. Morris, *Pecopteris* and *Zamites*, and these in patches and fragmentary, scattered through certain portions of the beds overlying the slate. But these must be limited to particular spots, for in the four quarries I visited on Collyweston Hill I saw scarcely a trace of any, and I was struck by their apparent rarity in that district, compared with their abundance in certain divisions of the slate at Sevenhampton and other localities near Cheltenham. The absence of the varied flora so characteristic of the slate near Cheltenham and Oxford, is not more remarkable than is that of the other interesting terrestrial and marine remains which it there contains. I saw no teeth or bones of reptiles and fish, nor elytra of beetles, nor could I learn that the workmen had ever observed any; and hence *zoologically* the Collyweston slate differs more from its south-western equivalents than it does in its internal *mineralogical* structure. These facts lead to the inference that it was deposited beneath a deeper sea, and at a greater distance from land, whence we should expect to find few evidences of neighbouring coasts, and a larger assemblage of marine exuvæ, the denizens of deeper water, though the genera would not be very numerous.

On the whole, the Great Oolite and its associated beds in their extension northwards, bear a closer resemblance to the Yorkshire than to the Bath and Minchinhampton series, except a portion of the upper beds at Ketton and Casterton.

For further details I may refer to the "Notice of the Geology of the neighbourhood of Stamford and Peterborough," by Captain Ibbetson and Mr. Morris, published in the Transactions of the Meeting for the Advancement of Science, 1847. When I visited Lincolnshire I had not seen this interesting paper, and it appears that we had independently arrived at the same conclusions.

Great Oolite (continued) North of Grantham.

There are some large and valuable quarries of Great Oolite at Auncaster, eight miles north-east of Grantham, which have long been famous for their beautiful building-stone. The following section will explain its general character in descending order:—

1. Blue clay, in which I could detect no fossils; perhaps the representative of the Bradford clay, which in Wilts immediately overlies the Great Oolite, and often separates the minor subdivisions. Near the top it is traversed by a thin dingy-white kind of marl, with a few imperfect impressions of plants	ft. in. 12 0
2. Ragstone—coarse, shelly, hard oolite	5 0
3. Sandy, soft (rarely shelly) oolitic freestone, variously coloured, yellow, pink and white, which often gives it, from its variegated wavy hues, a beautiful appearance. This forms the famous building-stone, and yields very large blocks	17 6
4. Hard, shelly oolite, generally of a blue colour. Not worked	16 0
5. Soft white stone below, depth uncertain.	
Total	50 6

Near the above is another quarry, in which the strata above the freestone are thicker, the blue clay no. 1 amounting to a thickness of 20 feet, and resting upon a hard blue stone containing many shells, especially a large species of *Avicula*, and broken fragments of carbonized plants, but too imperfect to determine. There is a soft, yellow, sandy band at its base also full of similar vegetable remains;—the total thickness of the two beds does not exceed 2 feet. The white rag, equivalent to no. 2 in the previous section, is only 1 ft. 3 in. thick, and reposes on the freestone.

The fossils in the ragstone and freestone are small and not numerous, and as I could obtain only two genera, *Arca* and *Cardita*, the shells of which were much waterworn, no comparison can be instituted between them and the equivalent series at Bath and Minchinhampton. The abundant remains of plants, and their rarity in Gloucestershire and Somerset in the *Great Oolite*, seem to indicate a closer affinity, zoologically, with the Yorkshire oolites; and I am informed by my friend Mr. Lycett that he and Mr. Morris could identify very few of the *Great Oolite* fossils of the north with those of the south of England. The building freestone is perhaps softer, as a mass, than that near Stroud and Bath, while it is remarkably distinguished by its waved, purple and pink colours, which give it the appearance of certain portions of the new and old red sandstones, and add greatly to the beauty of the material for architectural purposes.

Inferior Oolite.

The *Inferior Oolite* takes a less regular course in its extension on the north-east of the Cotswold chain of hills. It is bounded on the east by the *Great Oolite*, and on the west by the lias; but as it has been subject to great denudation in the counties of Northampton, Rutland and Lincoln, the escarpments generally are less bold and rugged, and the hills comparatively low. In Lincolnshire it forms a bleak, open country like the Wolds of Gloucestershire, and it is well-adapted for turnips. The stone frequently lies close to the surface, so that the soil is very stony, like the cornbrash in Wiltshire, and this probably is mainly attributable to the amount of aqueous action to which it has been subject. In parts of Rutlandshire the soil is of a deep red colour (which distinguishes the upper beds in the Cotswolds), and much better wooded than in the neighbourhood of Grantham; but in no case does it afford that romantic and beautiful scenery which especially characterizes the *Lower Oolites* in Gloucestershire. The village of Denton four miles south-west of Grantham is certainly a pretty spot, and there the *Inferior Oolite* bears a close lithological resemblance to a portion of the series at Leckhampton, Crickley and elsewhere. The following is a sec-

tion (in descending order) of Green's quarry on the summit of the hill :—

	ft.
1. Rubble, about.....	2
2. Oolite marl.....	4 or 5.
3. Soft, shelly, white and yellow, though sometimes brown oolite, not quarried deep.	

The oolite marl is nearly identical with that near Cheltenham, though rather darker in colour, and much reduced in thickness. It is loaded with corals as at Crickley, many of which, as far as I could judge, appear to belong to the same species as those in Gloucestershire. Some parts of the bed are softer and full of shells, among which I procured several species of *Cerithium*, *Nerinæa*, *Natica*, and other genera. *Natica macrostoma*? is abundant, and a species of *Rostellaria* also occurs, though rarely; the edges of the beds have been much waterworn, probably by currents, and the shells are exposed in relief, and are much weathered in consequence. I sent a small collection to our colleague Mr. Lycett, and he states that although the greater number were new to him, yet the tendency of the others is towards the Inferior Oolite, and agree specifically with some in our district. Such for instance as the *Natica adducta* (an oolite marl shell), but also found in the Great and Inferior Oolite of Yorkshire; *Trigonia striata*, from the Roestone and Gryphite grit; while at the same time there is a new species of *Acteonina*, *Monodonta*, &c. At so great a distance we must expect this to be the case, and the identity of a stratum (where the order of superposition is clearly defined) may be sufficiently proved if we can find a few distinctive species in both localities, and among these the *Natica macrostoma*?* is certainly one, a fine series being preserved in the Grantham Museum. It is to be hoped that a larger collection will soon be made, and a careful comparison instituted between the Inferior Oolite fossils of Gloucestershire and Lincolnshire. Much has yet to be done in the Oolites generally in England, and with the exception of the standard and invaluable work, 'The Geology of England and Wales,' by Conybeare and Phillips, and a few local papers, very little is known of the oolitic districts N.E. of the Cotswolds, especially in Lincolnshire, Rutlandshire and Northamptonshire; and a wide field is open for the research of an active and intelligent geologist in that quarter; and as our science is strictly a progressive one, inexhaustible and as yet hidden treasures, rich in their way as the

* With respect to this species, Mr. Lycett is of opinion that it cannot be referred to any known species, and he proposes to call it *Natica Leekhamptonensis*. It appears to be confined to the oolite marl, as many others are, and I have never yet seen it in any of the superior or inferior beds.

gold of California, may be in store for us. In our Inferior Oolite, corals are more or less distributed throughout the whole; but no one stratum contains them in greater abundance than the oolite marl, the upper division of which at Crickley has been correctly denominated the "coral bed," and evidently formed an extensive coral reef beneath the ocean; but with the exception of the pisolite, we have no further evidence of such reefs in any of the other superior or inferior beds. Hence the abundance of corals in the oolite marl near Grantham, coupled with other facts, such as the frequency of *Nerinae*, which are usually found associated with corals, and are believed to have inhabited shallow seas, tends to support the probability that the marl in Lincolnshire was deposited under similar conditions to the marl in Gloucestershire, although many of the shells may be distinct, a very little geographical distance in a sea-bottom being often sufficient to produce a corresponding increase or decrease in the number and variety of species.

I observed the marl occupying a similar position nearer Grantham, where it is harder, whiter, and extensively used for roads, and contains many small shells and corals. The soft, white and yellow oolite (no. 3, p. 56) affords many small shells, and forms a tolerable building-stone; but as it is never quarried deep, I could not ascertain its thickness, nor the nature of the lower strata; but there must be a considerable mass of oolite probably intervening between it and the subjacent lias. One of the numerous trial-borings on Harrowby Hill near Grantham gives the following section:—

	ft.	in.
Soil	0	6
Rubble	6	0
Inferior oolite	40	6
Lias (blue bind) continued downwards ..	10	0

by which it appears that thereabouts the total thickness of the Inferior Oolite does not exceed 41 feet. As a portion of no. 3 is a friable freestone, it may be considered as the representative of the shelly freestone underlying the 'oolite marl' at Leckhampton. Nearer Grantham also there is a fragmentary, shelly oolite on the side of Ponton Hill, which is possibly a continuation of the same bed; but a more accurate investigation is required before this can be positively determined. There are so few natural or artificial sections in the country that it is extremely difficult to obtain correct information; and although two lines of railway are now being constructed, the engineers employed know nothing of geology, and are therefore incapable of rendering any assistance.

In the Institution at Grantham there is a very tolerable col-

lection of Inferior Oolite fossils, chiefly from Denton, among which were several Clypei and other shells common to Crickley and Leckhampton.

There can be no doubt that the beds above the oolite marl once existed in Lincolnshire, as the gravel near Grantham, to which I shall presently allude, contains numerous fragments of oolite, and I recognized in them certain shells which are characteristic of some of the strata which overlie the marl at Leckhampton. There may be some spots in that and the adjoining counties where these higher bands exist still *in situ*, but from the general appearance of the country I am led to infer that the degradation to which, from various causes, they have been exposed, has removed a considerable portion of the upper division of the Inferior Oolite. While moreover the Great Oolite bears a closer resemblance in some respects to the Yorkshire series, the Inferior Oolite in the districts under review would seem to be more nearly allied to the more enlarged and coeval system in Gloucestershire. Still nothing decisive can be stated upon this point at present, until the strata and their organic contents have been more accurately investigated, and a careful comparison instituted by competent persons between the Lower Oolites in the northern, midland, and south-western portion of England*.

Upper and Lower Lias.

The Lias in its north-eastern course runs nearly parallel to the *lower* division of the Oolites, from the Cornbrash to the Inferior Oolite inclusive; but while the latter *diminish in breadth* towards the Humber, the former occupies a considerable area from E. to W., though less expanded thereabouts than it is in some of the midland counties, and in its course thence in a south-westerly direction. Although, like other formations in different and distant localities, this varies in *extent and thickness*, it preserves, on the whole, a greater persistency and uniformity of character throughout the whole world than any other deposit; so that groups of fossils and detailed sections, either from Germany or Asia (the Himalayas for instance), are found to correspond very closely with those in our own country. In a collection of lias fossils from the Cape of Good Hope, exhibited at the Geological Society in December last, I was struck with the close resemblance which they bore to certain species with which I was familiarly acquainted in this vale, although there were some, as might be expected, which were new to me.

* Perhaps there is no locality in England where the Inferior Oolite may be so well studied in detail, or where it is so extensively developed, as in the outer escarpments of the Cotswolds.

The junction of the Inferior Oolite and Upper Lias shales may be observed near Stamford, and many of the characteristic fossils have been noticed. It also crops out at the base of some of the numerous longitudinal valleys which traverse the oolitic district round Grantham, and it may cap some of the hills on the north of the town. In a short visit I was unable to examine this part of the series more closely, but as these seem to be mainly composed of the ferruginous beds underlying the marlstone, it is probably of limited extent and thickness. These hills overlook a low and extensive flat, occupied almost exclusively by the *middle beds* of the Lower Lias, so largely developed at the Leigh and other spots throughout the Vale of Gloucester, and in no respects differing from them. The soil is cold and wet, like all clay soils, but the general aspect of the tract is most uninteresting, and by no means equal to the rich and often picturesque valley through which the Severn flows. The Vale of Belvoir, however, more to the west, is a richer country, and the castle, which stands on oolitic, well-wooded hills, commands a fine view over the lias and new red sandstone in Nottinghamshire. In this neighbourhood the marlstone abounding in fossils is largely developed, and also in the descent from Denton Hill into the valley in which Grantham stands. It there occupies the same relative position, and presents the same geographical features as it does in Gloucestershire, Warwickshire and Somersetshire.

A railway cutting through Gonnerby Hill close to Grantham has exposed the top beds of the Lower Lias, undistinguishable either lithologically or zoologically from their equivalents at Hewlett's and Robinswood Hills near Cheltenham and Gloucester. The ochraceous and laminated lias of Professor Buckman, with their characteristic fossils, are well seen in a deep cutting, in the latter of which, nodules and layers of ironstone are extensively distributed. The specimens which I procured, and the collections I saw from this part of the series, agree precisely with those obtained in similar strata in Gloucestershire. This division of the Lias constitutes comparatively low hills N.W. of Grantham, not capped by oolite, which takes a more northern course towards Lincoln. A considerable portion of the former town stands upon sand and gravel, but the lower division of the Lias has been penetrated for wells to the depth, as I was informed, of ninety feet; but from the difficulty I had in obtaining sections in any of the inferior strata, I am unable to say whether it agrees exactly in this respect with those in the Vale of Gloucester. The Lower Lias generally may be best studied N.W. and W. of Grantham, on the S. and S.E. of which the oolitic Wolds rise and rarely display the Upper Lias at their base. West of the town towards Nottingham the junction of the red marl and lias is probably visible,

though I did not myself see it; at all events the '*Insect Limestone*' occurs at Granby between Denton and Nottingham, for in the Grantham Museum there is a beautifully perfect fish, apparently a *Dapedium*, from this stratum; the structure of this limestone being so peculiar, that in the absence even of insect remains, I had no difficulty in recognizing it. In this case, this is the furthest point *northwards* in which it has been hitherto detected; and as it is largely quarried at Barrow on Soar near Mount Sorrel in Leicestershire, its course may in all probability be traced southwards with tolerable regularity into Warwickshire, Worcestershire and Gloucestershire; and it may extend, and very likely accompanies the red marl in its range still further to the *north*, perhaps even to the north-eastern coast of Yorkshire.

The Gravel.

The gravel in places near Grantham, especially at Ponton Hill, two miles south of the town, is extremely interesting, and there of some extent and thickness. It is mainly composed of the debris of the inferior oolite, chalk flints, and other older primitive rocks, such as granite, mica schist, porphyry, hard quartzose sandstone, trap, and slate. I also observed boulders of mountain limestone and Caradoc sandstone with characteristic fossils. None of these boulders are very large. The gravel is evidently derivative, and belongs to the period of the great northern erratic drift, so extensively distributed over the counties of Northamptonshire, Buckinghamshire, Cambridgeshire and Essex. Near Cambridge a similar gravel may be observed, but the fragments of which it is composed are much smaller, being at a greater distance from their source. The gravel on Ponton Hill is thirty feet thick: animal remains, so abundant in some localities in England, seem to be extremely scarce, for the labourer who had worked there for years stated that he had never found anything except a portion of a stag's horn, about ten feet from the surface. At Bottisford, however, west of Grantham, there is a bed of clay probably of a different age to the gravel above-mentioned, containing bones of elephants, ox, deer, &c.

Conclusion.

Allow me, Mr. President, in conclusion (while we may justly congratulate ourselves on the prosperity of our Society), to express a hope that each of our members will in his turn contribute his share to the stock of general knowledge and new facts which it is the object of our scientific meetings to promote. A good dinner certainly is not a bad thing, and frequent reunions of scientific friends are extremely delightful; but our aim must be a

higher one, and we must endeavour to advance as much as possible those nobler and more enduring pursuits which enlarge the mind and benefit our fellow-creatures. Every one, however limited his acquaintance with science in general, has it in his power even in his daily walks to observe the structure and nature of the animate and inanimate world. Beautiful and varied too as the wide field of nature is, it seems almost culpable to pass by unnoticed the many wonders which it contains, though the choicest are often hidden from the unobservant eye. Yet there are flowers rich and rare, and gems of costly price, the tempting rewards of meritorious zeal and diligent research. A new flower, a new insect, a habit or an instinct in the higher animals not before noticed, may be discovered by a mere beginner, and *one recorded fact* is worth a thousand hasty generalizations founded on mere negative evidence, or theoretical deductions. There is much yet to be done, not only in geology, but in every other branch of knowledge; and truth is best elicited, and false reasonings most satisfactorily overthrown, by an earnest, patient and laborious search into the novelties and beauties of God's creation, not studied in the closet alone, but amidst the plains and rocks, the woods and streams, and even in the recesses of the "vasty deep."

In this way, such master-minds as Sedgwick, Murchison, Owen, Lyell, Forbes and others, have read the pages of the book of nature, and have shown us how to unravel its mysteries, and to study and appreciate the glorious handiwork of an Omnipotent Creator.

Tabular view of Fossil Shells from the middle division of the Inferior Oolite in Gloucestershire. By JOHN LYCETT, Esq.

READ 30TH JULY 1850.

THE term middle division of the Inferior Oolite has been adopted from an arrangement of this formation made by Sir R. Murchison in 1834, and which, with some slight modification, will be found to be a convenient one for the zoological as well as for the mineral character of the divisions. The following comparison of fossil testacea from the middle division of the formation at Leckhampton and Crickley Hills with others from a similar geological position near Minchinhampton, and of both collections with Great Oolite shells of the latter place, has been undertaken for the following reasons. The Leckhampton shells constitute a numerous assemblage, have only recently been procured or investigated, and present a striking contrast with those of the upper and lower divisions of the same formation which are well known, and have for the most part hitherto supplied the numerous Inferior Oolite fossils to be found in museums and illustrated works. The person to whom the merit is due of having first drawn attention to this assemblage is undoubtedly Mr. Buckman, who having procured a few species was immediately struck with the similarity of aspect, and even specific identity, which they presented to certain Great Oolite shells which had previously been believed were peculiar to that formation: as the number of species increased the same general similarity of aspect was remarked, until at length an opinion was entertained by some of our Cotswold geologists, that a large proportion, perhaps even a majority of these shells, were identical with Great Oolite species. That the Leckhampton shells should not previously have been procured will excite no surprise, when it is stated that they are not to be *picked up*, nor do they immediately arrest the eye of the observer like many other Inferior Oolite fossils; they are usually small, even minute, and are disengaged from the investing stone only by great labour and perseverance. For the means of making this comparison I am indebted to the kindness and liberality of the Rev. P. B. Brodie, who has placed at my dis-

posal his numerous collection, and to whom, as votaries of natural history, our thanks are due for the indomitable perseverance with which he has followed up the investigation of this very characteristic assemblage of shells. In the mean time having procured a considerable number of species from the same division of the Inferior Oolite near Minchinhampton, and been accustomed to compare them with Great Oolite shells of the same vicinity, I became desirous of making the following comparison, with the view of testing how far the two collections placed upon the same geological parallel, but fifteen miles asunder, resembled each other, what proportion of either and of both passed upward into the Great Oolite, and lastly, what amount had previously been figured and described; tables accompanied by notes, if carefully prepared, would obviously to a great extent supply this desideratum; and although the number of species procured from each locality probably falls far short of what will ultimately be obtained, the tables it is hoped will not be destitute of utility even in another point of view—they can be placed in comparison with collections from the Ragstones of the Inferior Oolite, and the zoological resemblance or difference between them ascertained. By following out this plan I am precluded from interfering with the labours of those who have recently investigated the geology of the Cotswolds, of Messrs. Buckman, Strickland and Brodie, to whom so much of our present amount of knowledge respecting these hills is due.

It would indeed have been desirable had the tables been made more comprehensive, so as to include the fossils of the upper and lower divisions of the Inferior Oolite; but a little reflection convinced me that by doing so I should be arrogating an amount of knowledge which I am very far from possessing; inasmuch as the information to be gathered from the literature of the science would scarcely be available for such a purpose, the general term Inferior Oolite with a locality attached being usually the amount of information of the position of a shell in this formation.

The Inferior Oolite in the vicinity of Cheltenham exhibits two very distinct assemblages of organic remains; the difference between these is so obvious, even to the uninstructed observer, that a glance at any well-arranged collection is sufficient to establish conviction of this fact. The upper of these assemblages is contained in the several beds called Upper Ragstones, numbered 1, 2, 3 and 4 in Mr. Strickland's valuable section of Leckhampton Hill* which is about to be published, where the united thickness assigned to them is 38 feet;

* See Quart. Journ. Geol. Soc. 1850, p. 249.

the whole of the formation beneath, with the exception of about $2\frac{1}{2}$ feet, or about 189 feet of rock, belongs to the second zoological assemblage, which it is the especial object of this comparison to elucidate. The Inferior Oolite has long been known to geologists for the great profusion which it possesses both in species and individuals of the two great tribes of Ammonites and Belemnites; some few of these pertain to the first or uppermost of our assemblages, but the great mass of these tribes, together with a large and characteristic series of other shells, are absent in the neighbourhood of Cheltenham; these constitute a third and still lower zoological series, to examine which, *in situ*, we must visit the escarpment of the Cotswolds, some miles to the southward of Leckhampton, and from thence we shall find this assemblage to be persistent in gradually increasing importance to the neighbourhood of Bath, and to extend throughout the whole course of the formation in Somerset and Dorset to the English Channel. In the two last-mentioned counties the localities of Dundry, Sherborne and Bridport have become celebrated for the profusion of their fossils, and until very recently museums and collections have been supplied almost exclusively from those sources, and the fossils of this third and lowest assemblage have been held to represent those of the Inferior Oolite generally. In the middle portion of the Cotswolds, or from Stroud to Wootton-under-Edge, the three subdivisions of the Inferior Oolite are exhibited by the various sections; but a little to the southward of the latter place, the uppermost division and upper portion of the middle division thin out and are lost; at the same time the Fuller's earth above attains a much greater importance, its thickness, together with that of the Inferior Oolite, amounting to a little more than the aggregate thickness of the two formations about Cheltenham. The following imaginary section from Cheltenham to Bath will make the subject more clearly understood. Thus the Fuller's earth 148 feet thick at Bath has diminished to 70 feet at Stroud, and in the vicinity of Cheltenham to a very inconsiderable band of clay. The lower division of the Inferior Oolite (No. 4 in the section), consisting of several Ammonitiferous beds with brown sands beneath, altogether 70 feet thick, has diminished to 40 feet at Stroud, and at Leckhampton is represented by the lowest bed 2 feet thick, charged in the usual characteristic manner with Belemnites, beneath which are 6 inches of chocolate-coloured sands reposing upon the blue marls of the Lias. The upper division or Ragstones (No. 2 in the section) about 40 feet thick near Cheltenham is reduced to 20 at Stroud, and is ultimately lost to the south of Wootton as before mentioned.

The middle division (No. 3 in the section), nearly 190 feet thick

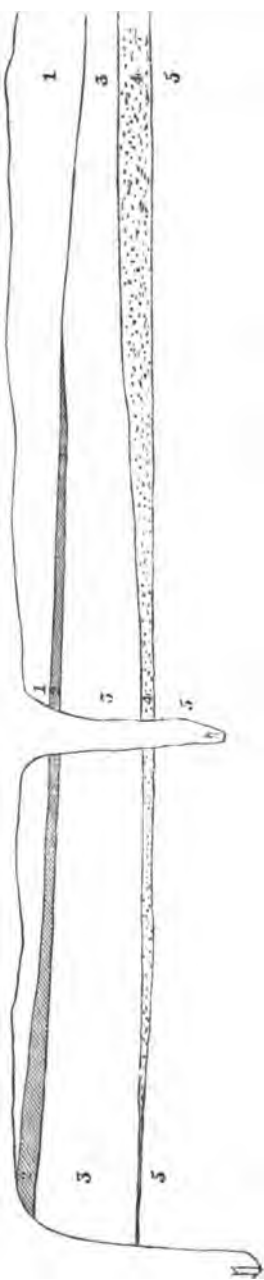
at Leckhampton, is somewhat diminished at Stroud, and loses the greater portion of its volume, including the Oolite marl and all the upper beds before it reaches Bath, where it is represented by 60 feet of freestone. The Bath section is taken from a valuable paper by Mr. Lonsdale in the Geological Transactions. The shells of the middle division are for the most part distributed in beds of no great thickness; the great mass of the deposit being nearly destitute of organic remains, or containing only minute shelly detritus.

The numerical results obtained from the Tables of comparison are as follow:—255 species have been examined from the middle division of the Inferior Oolite, 181 being from Leckhampton, and 145 from Minchinhampton; of these 73 are common to the two localities and 64 pass upwards into the Great Oolite, or 28 per cent. Of the Leckhampton shells alone 59, *i. e.* 33 per cent., and of the Minchinhampton Inferior Oolite suite 43, *i. e.* 31 per cent., pass upwards. Thus, from each of the localities, a larger per-centage of shells pass upwards than is obtained when the entire number of species are reckoned; an instance of the cautious reliance which should be placed upon estimates derived from a limited number of species or from shells of a single locality, where the object is to draw wide and general inferences. It should also be stated that about 40 species in addition to these were not sufficiently perfect to be determined, nearly or quite the whole of which are unknown to the Great

Bath.

Stroud.

Cheltenham.



1. Fuller's earth. 2. Upper Ragstones, &c. 3. Freestones, &c. 4. Lower rags and sands. 5. Lias.

Oolite ; this addition would still further reduce the per-centage of those which pass upward to the latter formation.

For remarks on particular species the notes which accompany the Tables should be consulted, but some further observations upon the several families of shells may here be given. The Leckhampton shells as a whole are remarkable for their diminutive size : this remark is not only applicable to those species which are likewise found in the lower and upper divisions of the same formation, but to those also which are found in the same formations at Minchinhampton. Upon the whole it may be stated that there is a nearer approximation between the Great Oolite and Leckhampton shells than between those of the two formations at Minchinhampton. As compared with the upper and lower assemblages, the middle is characterized by an entire absence of the *Pholadomyas*, the *Homomyas*, the *Gresslyas*, and I had almost said of *Ammonites*, *Belemnites* and *Nautili*, genera which constitute so large a proportion of the other assemblages, in this respect presenting a striking accordance with the contents of the shelly beds of the Great Oolite. Again, the large number of *Nerinea* and *Cerithia*, though differing specifically from those of the Great Oolite, tend much to separate it zoologically from the upper and lower assemblages, where they are few and rare. Mr. Brodie's collection has a single *Nautilus* and *Belemnite* ; my own has four *Ammonites* of one species, and a single *Nautilus* ; their presence under such circumstances is a sufficient indication of the solitary and perhaps accidental nature of their occurrence, a proof in fact that they did not live and propagate in the middle division. The *Rostellaria*, though few in number and differing specifically from those of the Great Oolite, serve also to mark the separation of the assemblage from other Inferior Oolite groups, and its approximation to the conditions of sea-bottom under which the Great Oolite shelly beds were deposited ; but the most striking circumstance which tends to the same conclusion is the occurrence of a great diversity of forms in the family of the *Patelloidea*, which appears to be altogether absent in the upper and lower series ; of the fourteen species it will be observed, that no less than six are specifically identical with Great Oolite forms ; and what renders this fact the more worthy of notice is, that the entire family are absent in the Inferior Oolite contemporaneous beds at Minchinhampton. The *Terebratula*, which usually are of much importance in the determination of particular groups of rocks, are abundant in this division only in the bed of Oolite marl ; but in localities where the marl is consolidated into a cream-coloured mudstone, or where a considerable number of other genera of shells are present, the *Terebratula* are comparatively scarce ; the genus however is one which conduces much to

impress an individual or distinctive character upon the assemblage, or to isolate it from other shelly deposits; it will be observed that of the twelve species two only of them appear to have been continued to the period of the Great Oolite; the other species do not even seem to be found in the other divisions of the same formation, each of which has its distinctive *Terebratula*.

The vertical range of the several species throughout the middle division is considerable, for with the exception of certain small and very rare species, the same *Terebratula* may be found to occur at intervals through a vertical thickness of 140 feet of rock. The genera which may be pointed out as most eminently to characterize this division are the *Cerithia*, the *Nerinea*, the *Trochi*, the *Solaria*, the *Cylindrites*, the *Melania*, the *Rostellaria*, the *Trochotoma*, the *Tancredia*, and the *Terebratula*; of these tribes all but two belong to the Gasteropoda; they constitute the great bulk of the univalves, and contain in all fifty-two species, not one of which is found in the Great Oolite. Other genera might be mentioned whose species equally belong to this series, but such have been selected as acquire importance either by the number of their species or by that of the individuals of such species. It may perhaps place the subject in a more striking point of view when it is stated, that of the 108 Gasteropods only 20 are continued to the Great Oolite. The smaller per-centage obtained from the total number of species when compared with a single locality is caused by a large proportion of the shells which are common to the two localities being likewise those which pass upwards into the Great Oolite, thus illustrating the fact, that species which occur in considerable number and have a wide range horizontally, are those which we should expect to find through a considerable range of beds vertically.

I would define the limits of the middle or freestone division of the Inferior Oolite as including all that portion of the formation situated between the upper ragstone beds (1, 2, 3 and 4 of Mr. Strickland's section), and the Ammonitiferous beds or upper portion of the lower division.

Lastly, the general conclusion may be stated to which this comparison has led, that these testacea constitute a zoological assemblage distinguished from those of the other portions of the Inferior Oolite by features as well-marked as those which distinguish the fossils of the other great groups (proximate in sequence), which are termed formations, from each other, and that these features, varying in detail, will probably be found to occur, like some other shelly deposits of the oolitic formations, at intervals and over small areas wherever the freestones of the Inferior Oolite are extensively developed.

On Tancredia, a fossil genus of Lamellibranchiate Conchifera.

Plate II. figs. 8, 9, 10.

Gen. Char. Shell thin, equivalve, inequilateral, smooth, flattened, subtrigonal or transverse, somewhat gaping at the posterior extremity, which is produced and attenuated; anterior side with a longitudinal angle passing from the umbo to the antero-ventral border. Hinge with two cardinal teeth in each valve, the anterior one the larger, and a wide and deep, rather irregular fossa between them; lateral teeth distant, one or two in each valve (usually two); ligament probably partially internal and contained in the cardinal pit.

The figure of the cardinal pit varies in the different species; in one it is triangular, one of the angles being at the umbo, in others it is wider and more irregular, but there is not any raised edge bordering it, as in *Mesodesma* and the *Lutraræ*; the figure and size of the cardinal teeth likewise vary; occasionally the posterior cardinal tooth can hardly be distinguished; strictly speaking, the anterior cardinal tooth is immediately beneath the umbo, the pit and other tooth being posterior to it; the posterior lateral tooth is sometimes wanting altogether; the internal margins of the valves are smooth; the valves are thin and delicate, but such as have had their internal surface exposed showed no traces of the muscular impressions. This genus may be classed as one of the *Mastracea*, and placed near to *Mesodesma* and *Amphidesma*; the external figure is donaciform; the character of the dentition approaches near to, but is really distinct from, *Mesodesma*, from which latter genus the gaping posterior extremity tends to separate it; the shell is likewise thinner and more delicate than in either of the genera with which it has been compared; with *Donax* it has nothing more in common than the external form.

This genus of small bivalves is eminently characteristic of the lower members of the oolitic system of rocks; the Great Oolite has three species, and the freestone beds of the Inferior Oolite have two other species; neither of these are common to the two formations, nor have they been found in the upper or lower divisions of the Inferior Oolite. The diffusion of this generic form is worthy of notice; it may without exaggeration be said, that certain layers in the shelly portion of the Great Oolite were merely so many colonies in which they propagated almost exclusively in countless numbers, but the great mass of these are of one species; the freestone beds of the Inferior Oolite contain likewise a great number of another species. A knowledge of these five species is of importance in the recognition and distinction of the shelly beds in the two formations, as from the numbers of two or three

species they may be expected to occur over large areas ; already they are known in the lower oolitic system of Normandy.

The generic appellation is derived from the name of Sir Thos. Tancred, Bart., the founder of the Cotswold Naturalists' Club.

The descriptions of two species will be found in the notes to the tables of Inferior Oolite shells ; those of the Great Oolite are deferred to the monograph upon that subject.

Note on No. 199, Ptychomya ? Agassizii.

At pl. 11. f. 3, 4 of the 'Etudes critiques sur les Mollusques fossiles,' by M. L. Agassiz, is an imperfect impression of an oblong flattened bivalve shell to which is affixed the new generic appellation *Ptychomya*, but no account is given of the locality or geological formation to which it belongs ; the figure is founded upon a single impression. M. Agassiz has not ventured to define the genus, and in his introduction mentions that M. D'Orbigny considers it to be a *Crassatella*, to which genus M. Agassiz remarks it has no external resemblance.

Having long possessed specimens of a small shell which exhibits the external characters of *Ptychomya*, and as two of the specimens are in a condition nearly perfect, I have ventured to record the little information thus acquired with the impression, that although meagre and imperfect, it should not be withheld when the object of investigation is obscure or unknown ; nevertheless the present note would not have appeared but for the necessity of affixing a generic name in my Tables to the little shell in question. The high degree of critical acumen displayed by the talented author of the 'Études,' together with the just confidence which he shows in the accuracy of his own observations and deductions when controverted by others, rendered it probable that the generic value which he had claimed for this obscure form would eventually be found to be justified ; the present species therefore became an object of interest upon the discovery that it could scarcely with propriety be assigned to any other known genus.

Ptychomya ? Agassizii. Pl. II. fig. 6.

Figure suborbicular and flattened ; umbones straight, small, pointed and mesial ; the substance of the shell thick ; the lunule indistinct or very slightly excavated ; the hinge-line posteriorly straight or slightly curved and sloping obliquely ; the ventral border rounded, the surface with about fourteen rounded, broad but depressed costæ, which are curved upwards and meet the costæ of the opposite side upon the middle of the shell forming an angle, the points of junction of the several costæ being upon a line passing obliquely from the umbo to the antero-ventral

border; the costæ are crossed by very fine, closely arranged encircling striæ or lines; the hinge is without teeth. Height 3 lines, breadth 3 lines.

The impression figured by M. Agassiz has a much more oblong or transverse figure, being much lengthened posteriorly; it is also rather imperfect or truncated at that extremity; the angle of the costæ is placed much more anteriorly than in our species, but inclines like the latter to the antero-ventral border; the costæ are likewise more narrow and numerous. Considering the flatness of the valves and their thickness, it would appear that the mollusk was shielded rather than inclosed by them; the valves would appear to have been open all round except at the ligament; the character of this latter organ must for the present remain doubtful, as no trace of a lamina for its attachment is visible. Our present imperfect definition of the genus *Ptychomya* therefore will be as follows:—Shell equivalve, suborbicular or oblong and transverse, flattened, thick; umbones small, straight, flattened; hinge-line posteriorly straight or slightly curved; valves open all round; surface with numerous curved ribs meeting at an angle, whose apex is directed towards the umbo; the costæ are covered with numerous, closely arranged, concentric striæ or lines. Hinge edentulous.

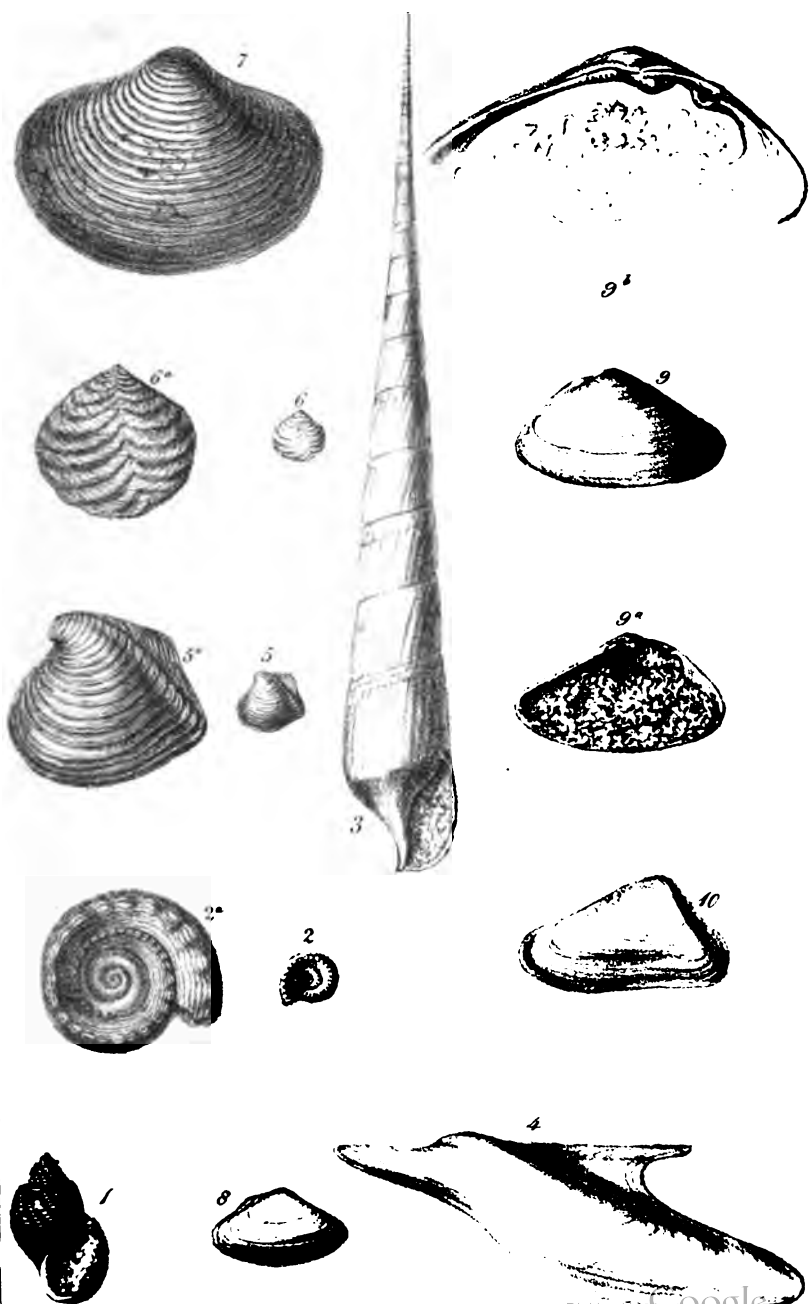
Of the fossil *Myadæ*, *Goniomya* is the only one which resembles it, but in that genus the costæ meet at an angle inclined in an opposite direction to *Ptychomya*; the surface has similar fine concentric lines, but here the resemblance appears to cease.

The true position of our genus in the molluscan tribes must therefore remain in abeyance; the smallness of the object and hardness of the investing stone are formidable obstacles in the way of further information to be obtained from it.

EXPLANATION OF PLATE II.

- Fig. 1. *Turbo elaboratus*.
 — 2. *Solarium Cotswoldiæ*.
 — 2 a. The same magnified.
 — 3. *Chemnitzia gracilis*.
 — 4. *Gervillia aurita*.
 — 5. *Opis gibbosus*.
 — 5 a. The same magnified.
 — 6. *Ptychomya Agassizii*.
 — 6 a. The same magnified.
 — 7. *Corbis aspera*.
 — 8. *Tancredia donaciformis*.
 — 9. *Tancredia estensa*.
 — 9 a. Interior of the same.
 — 9 b. Magnified view of the hinge.
 — 10. *Tancredia truncata*.

The two latter species pertain exclusively to the Great Oolite.



Tabular List of Fossils.

Genus.	Species.	Authority.	Inf. Ool. Leck- hampton.	Inf. Ool. Minchin- hampton.	Gr. Ool. Minchin- hampton.
1. <i>Patella</i>	<i>rugosa</i>	Sow. Min. Con. ...	•	...	•
3. ———	<i>nitida</i>	Deslongchamps	•		
2. ———	<i>inornata</i>	new sp.	•	...	•
4. ———	<i>retifera</i>	new sp.	•		
7. <i>Emarginula</i>	<i>planicostula</i>	Deslongchamps	•		
8. ———	<i>scalaris</i>	Sow. Min. Con. ...	•	...	•
9. ———	<i>alta</i>	new sp.	•	...	•
10. ———	<i>granulata</i> ... [sis.	new sp.	•		
11. ———	<i>Leckhamptonen-</i>	new sp.	•		
6. <i>Fissurella</i>	<i>acuta</i>	Deslongchamps	•	...	•
5. ———	<i>Brodiei</i>	new sp.	•		
12. <i>Rimula</i>	<i>clathrata</i>	Sow. Min. Con. ...	•	...	•
12*. ———	<i>Blotii</i>	(<i>Emarginula</i>) Deslongchamps	•	...	•
13. ———	<i>tricarinata</i>	<i>Emarginula</i> , Sow. Min. Con.	•	...	•
13*. ———	<i>minutissima</i>	new sp.	•		
14. <i>Pileolus</i>	<i>lævis</i>	Sow. Min. Con. ...	•	•	•
15. ———	<i>plicatus</i>	Sow. Min. Con. ...	•	•	•
16. <i>Nerita</i>	<i>costata</i>	Phil. Geol. York.	•	•	
18. ——— ... {	<i>pulla</i>	Roemer	•	...	•
18. ——— ... {	<i>minuta</i>	Sow. Min. Con. }	•		
19. ———	<i>tumidula</i>	<i>Natica</i> , Phil. Geol. York.	...	•	
17. ———	<i>cassidiformis</i>	new sp.	•		
43. ———	<i>lineata</i>	new sp.	•		
20. <i>Naticella</i>	<i>decussata</i>	<i>Natica</i> , Goldfuss...	•	•	
50. <i>Natica</i>	<i>adducta</i>	Phil. Geol. York.	•	•	
52. ———	<i>macrostoma</i> ? ...	Roemer and Gold- fuss.	•	•	
53. ———	[sis. <i>Leckhamptonen-</i>	new sp.	•		
127. ———	<i>Gomondii</i>	new sp.	•		
21. <i>Monodonta</i>	<i>sulcosa</i>	<i>Nerita</i> , Archiac ...	•	•	•
22. ———	<i>Lyellii</i>	<i>Nerita</i> , Archiac ...	•	•	•
23. ———	<i>heliciformis</i>	new sp.	•	•	•
27. ———	<i>lævigata</i>	<i>Nerita</i> , Sow. Min. Con.	•	•	•
24. <i>Delphinula</i>	<i>funata</i> [lata.	Goldfuss	•	•	
26. ———	<i>quaterno-cingil-</i>	new sp.	...	•	•
35. ———	<i>lineata</i>	new sp.	•		
25. <i>Littorina</i>	<i>nana</i>	new sp.	•		
30. <i>Turbo</i>	<i>elaboratus</i>	new sp.	•	•	
28. ———	<i>capitaneus</i>	Goldfuss	•		•
29. ———	<i>princeps</i>	Roemer	•	•	
33. ———	<i>Cheltensis</i>	new sp.	•		
34. ———	<i>varicosus</i>	new sp.	•		
31. <i>Cirrus</i>	<i>nodosus</i>	Sow. Min. Con. ...	•	•	
			37	17	17

Genus.	Species.	Authority.	Inf. Ool. Leck- hampton.	Inf. Ool. Minchin- hampton.	Gr. Ool. Minchin- hampton.
36. Trochus.....	monilitectus ...	Phil. Geol. York. ...	37	17	17
37. ———	bi-cingendus ...	new sp.	•	•	
38. ———	alternans	new sp.	•	•	
39. ———	gemmatus [tus.	new sp.	•	•	
40. ———	cingillato - serra-	new sp.	•		
41. ———	pileus	new sp.	•	•	
42. ———	infundibuliformis	new sp.	•	•	
44. Pleurotoma- ria	funata	new sp.	•	•	
45. ———	laevigata	new sp.	•	•	
48. Trochotoma	calix	Solarium, Phillips; T. affinis, Deslong- champs.	•	•	
46. ———	carinata	new sp.	•	•	
47. ———	depressiuscula ...	new sp.	•	•	
49. ———	funata	new sp.	•	•	
51. Natica	canaliculata	new sp.	•	•	•
54. Phasianella	acutiuscula	new sp.	•	•	
55. ———	turbiniiformis ...	new sp.	•	•	
55*. ———	subangulata ...	new sp.	•	•	
56. Acteonina	tumidula	new sp.	•	•	
57. ———	ovata	new sp.	•	•	
58. ———	glabra	Acteon, Phillips ...	•	•	
59. Cylindrites	attenuatus	new sp.	•	•	
60. ———	gradus	new sp.	•	•	
61. ———	mamillaris	new sp.	•	•	
62. ———	tabulatus	new sp.	•	•	
63. ———	bulbiformis	new sp.	•	•	
64. Chemnitzia	nitida	new sp.	•	•	
65. ———	elegans.....	new sp. [champs.	•	•	
98. ———	procera?	Melania, Deslong- champs.	•	•	
99. ———	gracilis	new sp.	•	•	
66. Ceritella, n.g.	sculpta	new sp. [champs.	•	•	
99*. Chemnitzia	turris	Melania, Deslong- champs.	•	•	
67. Ceritella	tumidula	new sp.	•	•	
69. Scalaria	pygmaea	new sp.	•	•	
70. Solarium	Cotswoldiae	new sp.	•	•	
71. ———	diadema	new sp.	•	•	
72. ——— .....	.....	new sp.	•	•	
73. ——— .....	.....	new sp.	•	•	
74. Eulima	parvula.....	new sp.	•	•	
75. Rissoa	laevis	Sow. Min. Con. ...	•	•	•
76. Rissoina	obliquata	Rissoa, Sow. Min. C.	•	•	•
76*. ———	obtusa	new sp.	•	•	
77. Cerithium	.....	new sp.	•	•	
78. ——— .....	.....	new sp.	•	•	
79. ——— .....	.....	new sp.	•	•	
80. ——— .....	.....	new sp.	•	•	
81. ——— .....	.....	new sp.	•	•	
			63	45	20

Genus.	Species.	Authority.	Inf. Ool. Leck- hampton.	Inf. Ool. Minchin- hampton.	Gr. Ool. Minchin- hampton.
82. <i>Cerithium</i>		new sp.	63	45	20
83. ———		new sp.	•	•	
84. ———		new sp.	•	•	
85. ———		new sp.	•	•	
86. ———		new sp.	•	•	
87. ———		new sp.	•	•	
88. ———		new sp.	•	•	
89. ———		new sp.	•	•	
90. <i>Nerinea</i> ...	<i>Bruntrutana</i> ?	Archiac ?	•	•	
91. ———	<i>acicula</i> ?	Archiac	•	•	
92. ———		new sp.	•	•	
93. ———		new sp.	•	•	
94. ———		new sp.	•	•	
95. ———		new sp.	•	•	
96. ———		new sp.	•	•	
97. ———		new sp.	•	•	
100. <i>Fusus</i> ?	<i>carinatus</i>	Roemer	•	•	
101. ———	<i>obliquatus</i>	new sp.	•	•	
101*. ———	<i>carino-crenatus</i>	new sp.	•	•	
102. <i>Rostellaria</i>	<i>unicornis</i>	new sp.	•	•	
103. ———	<i>simplex</i>	new sp.	•	•	
104. ———	<i>spinigera</i>	new sp.	•	•	
105. ———	<i>solida</i>	new sp.	•	•	
106. ———	<i>gracilis</i>	new sp.	•	•	
107. <i>Serpula</i> ...	<i>laevigata</i>	new sp.	•	•	
108. ———	Undetermined		•	•	
108*. ———	<i>socialis</i>	Buckman	•	•	
109*. <i>Belemnites</i>	Undetermined		•	•	
109. <i>Nautilus</i> ...	<i>lineatus</i>	Sow. Min. Con. ...	•	•	
110. <i>Ammonites</i>	Undetermined		•	•	
111. <i>Echinus</i> ...	<i>germinans</i>	Phil. Geol. York...	•	•	
112. <i>Pygaster</i> ...	<i>patelliformis</i>	Agassiz	•	•	
113. <i>Cidaris</i>	<i>subangularis</i>	Goldfuss	•	•	
114. ———	Undetermined		•	•	
115. ———	<i>coronatus</i>	Goldfuss	•	•	
116. <i>Acrossalenia</i>	<i>Hoffmanni</i>	Goldfuss	•	•	
117. <i>Cidarites</i> ...	<i>crenularis</i>	Goldfuss	•	•	
118. ———	Undetermined		•	•	
119. <i>Nucleolites</i>	<i>clunicularis</i>	Goldfuss	•	•	
121. <i>Lima</i>	<i>punctata</i>	Goldfuss	•	•	
122. ———	<i>duplicata</i>	Sow. Min. Con. ...	•	•	
124. ———	<i>notata</i>	Goldfuss	•	•	
128. ———	<i>lunularis</i>	Deshayes	•	•	
129. ———	<i>laeviuscula</i>	Goldfuss	•	•	
123. ———	<i>squamicosta</i>	Buvignier	•	•	
125. ———	<i>plicata</i>	new sp.	•	•	
126. ———	<i>alata</i>	new sp.	•	•	
130. ———	<i>punctatilla</i>	new sp.	•	•	
130*. ———	<i>minutissima</i>	new sp.	•	•	
134. <i>Pecten</i>	<i>clathratus</i>	Roemer	•	•	
			97	72	32

Genus.	Species.	Authority.	Inf. Ool. Leck- hampton.	Inf. Ool. Minchin- hampton.	Gr. Ool. Minchin- hampton.
134*.	—	variety? of above.	97	72	32
135.	<i>Pecten</i>	<i>lens</i>	•	•	•
131.	—	<i>vimineus</i>	•	•	•
130*.	<i>Lima</i>	<i>ovalis</i>	•	•	•
136.	<i>Pecten</i>	Undetermined	•	•	•
137.	—	<i>lineolatus</i>	new sp.	•	•
138.	<i>Hinnites</i>	<i>sepultus</i>	new sp.	•	•
139.	—	<i>comptus</i>	<i>Spondylus</i> , Goldfuss.	•	•
140.	—	<i>velatus</i> [valve].	<i>Spondylus</i> , Goldf.	•	•
139*.	—	<i>tuberculatus</i> (left)	<i>Spondylus</i> , Goldf.	•	•
141.	<i>Plicatula</i>	<i>elongata</i>	new sp.	•	•
142.	<i>Placuna</i> ?	<i>jurensis</i>	Roemer	•	•
143.	—?	<i>armata</i>	<i>Plicatula</i> , Goldfuss	•	•
144.	—?	<i>complicata</i>	new sp.	•	•
145.	<i>Mytilus</i>	<i>pectinatus</i>	Sow. Min. Con.	•	•
146.	—	<i>striatulus</i>	Goldfuss	•	•
147.	—	<i>pulcher</i>	Goldfuss... [Con.	•	•
149.	—	<i>cuneatus</i>	Modiola, Sow. Min.	•	•
148.	—	<i>subrectus</i>	new sp.	•	•
150.	—	<i>crenatus</i>	new sp.	•	•
151.	<i>Dreissena</i>	<i>lunularis</i>	new sp.	•	•
152.	<i>Gervillia</i>	<i>tortuosa</i>	<i>Gastrochena</i> , Phill.	•	•
153.	—	<i>lata</i>	Phillips	•	•
154.	—	<i>aurita</i>	new sp.	•	•
155.	—	<i>costatula</i>	Deslongchamps	•	•
156.	—	<i>laevigata</i>	new sp.	•	•
157.	<i>Perna</i>	<i>mytiloides</i>	Goldfuss... [Con.	•	•
158.	<i>Gervillia</i>	<i>ovata</i>	Avicula, Sow. Min.	•	•
158*.	—	<i>complicata</i>	Buckman	•	•
159.	<i>Pteroperna</i>	<i>gibbosa</i>	new genus and sp.	•	•
160.	<i>Pinna</i>	<i>cuneata</i>	Phillips	•	•
161.	—	<i>hastata</i>	new sp.	•	•
164.	<i>Hiatella</i>	<i>interlineata</i>	new sp.	•	•
166.	<i>Myoconcha</i>	<i>crassa</i>	Sow. Min. Con.	•	•
163.	<i>Ostrea</i>	<i>costata</i>	Sow. Min. Con.	•	•
163*.	—	Undetermined	•	•	•
168.	<i>Opis</i>	<i>Moreausius</i>	Buvignier	•	•
169.	—	<i>angustatus</i>	new sp.	•	•
170.	—	<i>elongatus</i>	new sp.	•	•
171.	—	<i>gibbosus</i>	new sp.	•	•
172.	<i>Trigonia</i>	<i>clavo-costata</i>	new sp.	•	•
173.	—	<i>lineolata</i>	Agassiz	•	•
174.	—	<i>angulata</i>	Sow. Min. Con.	•	•
175.	—	<i>striata</i>	Sow. Min. Con.	•	•
176.	—	<i>costatula</i>	new sp.	•	•
177.	—	<i>v. costata</i>	new sp.	•	•
177*.	—	<i>tuberculosa</i>	new sp.	•	•
178.	<i>Corburella</i>	<i>curtansata</i>	<i>Corbula</i> , Phillips	•	•
			131	100	48

Genus.	Species.	Authority.	Inf. Ool. Leck- hampton.	Inf. Ool. Minchin- hampton.	Gr. Ool. Minchin- hampton.
181. Corbula ...	involuta	Goldfuss, striata, Buckman.	131	100	48
179. ———	imbricata	new sp.	•	•	•
180. ———	depressa	Phillips	•	•	•
183. Cypricardia	cordiformis	Deshayes	•	•	•
183. ———	siliqua	new sp.	•	•	•
186. Cardium ...	cordiforme	new sp.	•	•	•
187. ———	laevigatum	new sp.	•	•	•
188. ———	cognatum [tum.	Phil. Geol. York. .	•	•	•
189. ———	punctato - stria-	new sp.	•	•	•
190. ———	granulatum ...	new sp.	•	•	•
184. ———	semicostatum ...	new sp.	•	•	•
191. Sphæra ...	Madridi	Cardium, D'Arch. ; Cardium incer- tum, Phillips.	•	•	•
192. Venus	trapeziformis ...	Roemer	•	•	•
193. ———	curvirostris	new sp.	•	•	•
194. ———	Suevica	Goldfuss	•	•	•
195. Cytherea ...	picta	new sp.	•	•	•
196. Astarte.....	excavata	Sow. Min. Con. ...	•	•	•
197. ———	quadrata	new sp.	•	•	•
198. ———	bullata	new sp.	•	•	•
199. Ptychomya	Agassizii	new sp.	•	•	•
200. ——— ... {	depressa	Goldfuss	•	•	•
201. ——— ... {	sulcato-striata ...	Roemer	•	•	•
201. ———	Menkei	Unio, Dunker	•	•	•
202. ———	detrita	Goldfuss	•	•	•
203. ———	formosa	new sp.	•	•	•
215. ———	orbicularis	Sow. Min. Con. ...	•	•	•
204. Lucina.....	lyrata	Phillips	•	•	•
208. ———	despecta	Phillips	•	•	•
205. Corbis	aspera	new sp.	•	•	•
206. ———	ovalis	Phil. Geol. York. .	•	•	•
207. ———	laevigatus	new sp.	•	•	•
209. Psammobia	laevigata	Phil. Geol. York. .	•	•	•
210. Mactromya	globosa.....	Agassiz	•	•	•
211. Panopæa?	delicatissima ...	new sp.	•	•	•
212. Tancredia .	donaciformis ...	new sp.	•	•	•
213. ———	sulcata	new sp.	•	•	•
214. Nucula ...	variabilis	Sow. Min. Con. ...	•	•	•
216. Ceromya ...	concentrica	Isocardia, S. M. C.	•	•	•
217. ———	striata	Cardita, S. M. C. .	•	•	•
218. Macrodon .	Hirsonensis	Cucullæa, D'Arch.	•	•	•
219. Goniomya .	literata	Mya, Sow. Min. Con.	•	•	•
220. Arcomya ...	oblonga	Sanguinolaria, Buckman.	•	•	•
221. Myopsis ...	punctata	Sanguinolaria, Buckman.	•	•	•
			159	128	62

Genus.	Species.	Authority.	Inf. Ool. Leck- hampton.	Inf. Ool. Minchin- hampton.	Gr. Ool. Minchin- hampton.
222. <i>Myopsis</i> ...	<i>dilata</i>	<i>Mya</i> , Phill.; <i>Sanguinolaria</i> , Buckm.	159	128	62
223. <i>Arca</i>	<i>pulchra</i>	Sow. Min. Con. ...	•	•	•
225. —	<i>lata</i>	Dunker	•	•	•
2 —	<i>triseulcata</i>	Goldfuss	•	•	•
224. —	<i>rudiusscula</i>	new sp.	•	•	•
250. <i>Modiolarca</i>	<i>ovata</i>	<i>Arca ovata</i> , Buckm.	•	•	•
226. <i>Cucullæa</i> ...	<i>elongata</i>	S. M. C., not Phill.	•	•	•
227. —	<i>dense granulata</i>	new sp.	•	•	•
228. —	<i>amena</i>	new sp.	•	•	•
229. —	<i>cucullata</i>	<i>Arca</i> , Goldfuss ...	•	•	•
230. —	<i>elongata</i>	Phil. Geol. York. .	•	•	•
231. —	<i>triangularis</i> ? ...	Phil. Geol. York. .	•	•	•
233. —	<i>nana</i>	new sp.	•	•	•
249. —	<i>bipartita</i>	new sp.	•	•	•
248. —	<i>funiculosa</i> ?	<i>Arca</i> , Goldfuss ...	•	•	•
248* —	<i>obliqua</i>	new sp.	•	•	•
234. <i>Lithodomus</i>	<i>attenuatus</i>	new sp.	•	•	•
235. <i>Trichites</i> ...	<i>nodosus</i>	Lycett, Ann. Nat. Hist. 1850.	•	•	•
236. <i>Terebratula</i>	<i>simplex</i>	Buckman.....	•	•	•
237. —	<i>plicata</i>	Buckman.....	•	•	•
238. —	<i>fimbria</i>	Sow. Min. Con. ...	•	•	•
239. —	<i>resupinata</i> ?	Sow. Min. Con. ...	•	•	•
240. —	<i>ornithocephala</i> ?	Sow. Min. Con. ...	•	•	•
241. —	.....	new sp.	•	•	•
241* —	.....	new sp.	•	•	•
242. —	.....	new sp.	•	•	•
243. —	.....	new sp.	•	•	•
244. —	.....	new sp.	•	•	•
246. —	.....	new sp.	•	•	•
			184	146	69

Notes and Descriptions of New Species.

2. *Patella inornata*; ovate, smooth; apex pointed, moderately elevated, subcentral, but posterior and inclined slightly forwards. The Great Oolite shells are rather more elevated and pointed.

4. *P. retifera*; ovate, costated and cancellated; costæ numerous and unequal, crossed by numerous encircling lines; apex moderately elevated, posterior, but inclined forwards.

10. *Emarginula granulata*; ovately globose; apex curved posteriorly; costæ numerous, very fine, with others still more delicate alternating, and rendered granular by transverse encircling lines.

11. *E. Leckhamptonensis*; oval, depressed; apex posterior; costæ large, rounded and tuberculated where crossed by encircling lines; costæ twenty-six in number.

5. *Fissurella Brodiei*; figure a lengthened oval, rather depressed

apex subcentral ; costæ about forty-two, large, nearly equal, crossed by numerous encircling lines.

13*. *Rimula minutissima* ; almost microscopic, conical ; apex curved ; ribs radiating, rounded, numerous, closely arranged, indented by encircling striæ ; under surface nearly orbicular.

17. *Nerita cassidiformis* ; subhemispherical, angulated ; spire discoidal ; an elevated smooth encircling carina divides the body-whorl into two portions, the upper of which is flat and has a few fine encircling lines ; on the lower portion the lines are larger, rounded and closely arranged.

43. *N. lineata* ; very oblique ; spire of several whorls, not elevated and nearly concealed ; surface with numerous very fine longitudinal radiating lines.

53. *Natica Leekhamptonensis* ; spire elevated, whorls convex, the last enormously expanded, upper surface of the whorls rounded and sulcated ; aperture very effuse, orbicular. Only casts known. A gigantic species.

23 & 27. *Monodonta heliciformis* and *M. lævigata* ; these shells are smooth and depressed ; they have the tooth of *Monodonta*, but are without any basal sulcus or umbilicus ; they will appear in the Great Oolite monograph under the new generic name *Alostoma*.

26. *Delphinula quaterno-cingillata* ; subglobose ; spire of several whorls, angulated ; longitudinal costæ large, elevated, rather angular, impressed by numerous transverse lines ; umbilicus costated ; aperture orbicular.

25. *Littorina nana* ; small, smooth, thick ; spire elevated ; whorls few, convex, narrow ; aperture rather small.

9. *Emarginula alta* ; shell much elevated, compressed laterally ; apex curved posteriorly, the convex side beneath the apex having narrow, simple, smooth elevated ribs, of which the middle one is the most prominent ; there are also slight traces of smaller costæ upon the flattened sides of the shell ; the height exceeds the length of the aperture : rare.

30. *Turbo elaboratus* ; ovate ; spire elevated, whorls five, slightly convex and angulated ; surface above the angle smooth, horizontal, or even slightly concave, encircling ribs numerous, elevated, crossing numerous longitudinal elevations or costæ, which are indistinct upon the last volution ; aperture oval, its length rather more than half of the entire shell. Axis 11 lines : rare.

33. *Turbo Cheltensis* ; small ; spire elevated, whorls five, convex, nodulated, nodules in four rows, about sixteen in a volution, the nodules of each row connected by an encircling line ; nodules large, diminishing in size upwards in each successive row ; length $\frac{1}{4}$ th of an inch.

34. *Turbo varicosus* ; turreted, whorls six, convex, each with four encircling, rounded and smooth costæ crossing about eight large longitudinal elevations, which pass rather obliquely from left to right. Axis 2 lines.

37. *Trochus bi-cingendus* ; elevated, whorls rather concave, with

two encircling nodose ribs, one at each margin of the whorl, and three mesial circles of nodules.

38. *Trochus alternans* ; moderately elevated and costated, three nodulated costæ upon each whorl, the middle one the smallest.

40. *Trochus cingillato-serratus* ; whorls few, bicarinated, the lower carina much the larger, the intermediate space concave with small serrated circles of ribs ; the carinæ are longitudinally serrated.

41. *Trochus pileus* ; very elevated ; whorls few, concave, with longitudinal elevations united at the base, and overlapping the upper portion of the succeeding whorl, base discoidal.

42. *Trochus infundibuliformis* ; figure a low cone above, discoidal beneath ; whorls three or four, flattened, with numerous obscure longitudinal wrinkled lines.

41 & 42. These two remarkable species are placed provisionally in the genus *Trochus* ; it is probable however that they will ultimately be erected into a new genus.

44. *Pleurotomaria funata* ; elevated ; whorls five or six, convex above, but rather flattened at the sides, with numerous equal, closely arranged angular encircling ribs decussated by fine longitudinal lines. Fascia of the sinus broad, striated longitudinally, with an encircling elevated line bounding it upon each side.

45. *Pleurotomaria lævigata* ; discoidal ; whorls five, smooth, slightly convex ; fascia of the sinus narrow, forming a slightly convex band ; base smooth and discoidal.

46. *Trochotoma carinata* ; moderately elevated, acuminate ; whorls narrow, numerous, angulated, rendered concave both above and below by an elevated and acute carina ; the first three or four whorls have closely arranged encircling striae crossed by others longitudinal, but the larger whorls are perfectly smooth, or have only the oblique lines of growth ; the carina is formed by two parallel lines ; the base is widely and deeply excavated ; height $\frac{2}{3}$ ths of the basal diameter : rare.

47. *Trochotoma depressiuscula* ; depressed ; whorls five, narrow and angulated ; ribs below the angle three, above more numerous ; upper surface of the whorls concave, lower flattened ; base striated, excavation large, not deep ; height half the basal diameter : rare.

49. *Trochotoma funata* ; elevated, acuminate, nearly smooth ; whorls convex, their lower portions flattened, with numerous encircling granulated ribs, faintly traced, basal excavation contracted. Height about equal to the basal diameter.

51. *Natica canaliculata* ; ventricose ; spire elevated ; whorls five, acute, flattened at their sides, their upper surfaces deeply channeled, the angle of the whorls slightly tumid ; aperture obliquely ovate ; axis imperforate, last whorl very large and tumid ; axial diameter 1 inch 4 lines, transverse 1 inch.

54. *Phasianella acutiuscula* ; ovate ; spire small, acute, with four very narrow rather convex whorls, whose upper borders are disunited from the preceding whorls ; body-whorl much expanded and globose ; aperture large, $\frac{2}{3}$ rds the axial length ; axis 5 lines, transverse diameter 4 lines.

55. *Phasianella turbiniformis*; ovate, acute; whorls five to six, convex, narrow, last whorl large, ventricose; aperture large, oval, oblique, its length a little exceeding half of the axial and $\frac{4}{5}$ ths of the transverse diameter.

55*. *Phasianella subangulata*; ovate, lengthened; spire pointed; whorls rather convex, few, body-whorl large, ovate, subangulated in the middle; aperture elongated and oblique, its length equal to the transverse and $\frac{2}{3}$ ths that of the axial diameter of the shell.

57. *Acteonina ovata*; ovate; spire of moderate elevation, consisting of four flattened whorls, last whorl subcylindrical, large; aperture lengthened, oblique; axis 11 lines, breadth 6 lines.

56. *Acteonina tumidula*; spire small; body-whorl very large and tumid; aperture expanded anteriorly; axis 6 lines, breadth 4 lines.

59. *Cylindrites attenuatus*; conico-cylindrical; spire short, acute, of six whorls, which are very narrow and acute at their upper borders; body-whorl flattened and attenuated towards the base; length 8 lines, breadth 4 lines.

60. *Cylindrites gradus*; cylindrical, elongated; spire elevated; whorls five to six, step-like, but slightly rounded at the angles, the lower portions of the whorls perfectly flat.

The above-named two species of *Cylindrites* have elevated spires; those which follow have sunk spires, but exposed, the upper edges of the whorls being visible; the apex, which usually comprises the first two or three volutions, forms a kind of mamillary tubercle elevated above the depressed edges of the other whorls except the last. They constitute two very distinct sections.

62. *Cylindrites tabulatus*; conico-cylindrical, vertex large, but little depressed; whorls numerous, centre slightly mamillated and elevated; the figure is tuberoso and the vertex unusually large.

61. *Cylindrites mamillaris*; conico-cylindrical, elongated; sides of the body-whorl flat, its upper edge acute; the inner whorls have their upper flat surfaces visible, the first two or three of which are elevated into a rounded or mamillary process. This nearly resembles a Great Oolite species, but it is less elongated, and the vertex is more depressed.

63. *Cylindrites bulbiformis*; very short or tun-shaped, the upper surface wide and flattened, but the apex rises a little; axis 4 lines, transverse diameter 5 lines.

64. *Chemnitzia nitida*; small, smooth; whorls five to six, convex, body-whorl large, oval, aperture oblique; length $\frac{1}{2}$ inch.

65. *Chemnitzia elegans*; subcylindrical, smooth; whorls numerous, convex, but short, their breadth exceeding their length; the body-whorl is symmetrical and not enlarged; apex unknown; length of fragment $3\frac{1}{2}$ inches, in which only the four last whorls are preserved.

99. *Chemnitzia gracilis*; spire excessively lengthened and acuminate; whorls very numerous, flattened or very slightly convex, longer than wide, sutures marked, aperture ovately elongated, pointed anteriorly; length 7 inches, diameter of last whorl 6 lines.

Ceritella, a genus related to *Cerithium*, which will be illustrated in a forthcoming monograph on the Testacea of the Great Oolite.

66. *Ceritella sculpta*; small, turreted; whorls few, long, nearly flat, each with three encircling striæ, equidistant; the body-whorl has six striæ besides numerous others closely arranged at the base.

67. *Ceritella tumidula*; small, smooth, much lengthened; whorls flattened, but slightly tumid at their upper junctions, body-whorl symmetrical; length $\frac{3}{4}$ inch.

69. *Scaloria pygmea*; shell minute; whorls seven, globose, the last whorl much enlarged; costæ eight in a volution.

70. *Solarium Cotswaldia*; depressed, both upper and under surfaces nearly equally concave; sides rather flattened, but with the borders rounded and furnished with numerous longitudinal elevations or nodules, twenty-eight upon the lower and twenty upon the upper border of the last volution; the entire surface has numerous narrow, crenated, encircling costæ, crossed by very fine longitudinal lines not always distinct; costæ upon the sides of the last whorl about fourteen.

74. *Eulima parvula*; minute; whorls five, convex, body-whorl rather large; apex obtuse.

76*. *Rissina obtusa*; spire obtuse; whorls slightly convex, six; outer lip moderately large; costæ numerous, closely arranged, slightly curved from right to left.

77 to 89 inclusive. *Cerithium*; the descriptions of the species of this genus are omitted for the reasons given under the genus *Solarium*, as are likewise of *Nerinea* 93 to 97 inclusive.

101. *Fusus obliquatus*; small, subconical, acuminate, longitudinal; costæ about nine in a volution, passing obliquely from left to right; base with several large encircling striæ, but the costæ are not continued to this part.

102. *Rostellaria unicornis*; spire lengthened, composed of many whorls, whorls costated, the costæ terminating in knobs on their upper portions; costæ ten in a volution, indented by five encircling striæ; last whorl smooth, with a single prominent carina, having an acute and elevated spire at one quarter of the circumference posteriorly from the outer lip; the wing single, rounded, curved, slender and produced; caudal extremity moderately long.

103. *Rostellaria simplex*; smooth; whorls long, few, convex; the spire moderately elevated; body-whorl with two carinæ, the upper one the larger, and forming two angles in its course; caudal extremity short. Only casts have been procured, but they are well characterized.

104. *Rostellaria spinigera*; spire elevated, acute; whorls few, each with seven prominent spines or spinous ribs; body-whorl spined above, grooved beneath; wing not digitated and but moderately expanded; caudal extremity straight and moderately long.

105. *Rostellaria solida*; spire turreted; whorls five, angulated by a circle of elevated longitudinal spinous ribs crossed by lines; body-whorl with a single carina, beneath which are several deep encircling grooves; wing simple, small, proceeding from the carina; caudal extremity short.

106. *Rostellaria gracilis*; spire lengthened, smooth; whorls six, lengthened, angulated, the angle being in the middle of the whorl forming an acute and crenulated carina; body-whorl smooth, with two

carinae and large digital processes; caudal extremity slender and lengthened; the slender form, crenulated carina and smooth surface distinguish it from *R. trifida*. Portions and casts of two other species of *Rostellariae* have been obtained, but not sufficiently perfect to admit of being described.

107. *Serpula laevigata*; a simple, round, smooth spiral tube, the tube being rather thick.

101*. *Fusus? carino-crenatus*; shell small, fusiform; spire of four volutions, keeled and striated; an elevated carina encircles the middle of each whorl, its edge undulated or crenulated; encircling striae cover the whole surface of the shell, and there is an indistinct circle of nodules upon the upper portion of each whorl near to the junction.

127. *Natica Gomondii*; small, globose; spire small; whorls convex, narrow, their upper margins cinctured with a narrow, flat, horizontal area, the outer edge of which is acute: rare.

125. *Lima plicata*; elongated, narrow; costae nine, very large and elevated, rounded and imbricated.

126. *Lima alata*; auricles very large, the length of the hinge-line being equal to that of the longitudinal diameter; anterior auricle much folded; ribs numerous, narrow, regular and imbricated.

130. *Lima punctatilla*; shell minute, gibbose, nearly straight; costae about twenty, rounded, large; interstitial spaces narrow; surface of the costae punctated where they are crossed by very fine lines.

134*. Possibly a variety of *Pecten clathratus* with large, elevated encircling ribs.

130*. *Lima minutissima*; oblique, broad, convex; costae fourteen, rounded, smooth, wider than the interstitial spaces, nearly evanescent upon the anterior side.

137. *Pecten lineolatus*; auricles large, striated; shell ovate, slightly convex; costae very minute, numerous, waved and granulated, degenerating into very fine lines towards the ventral border, and crossed by encircling lines, very fine, and arranged in the closest possible order.

138. *Hinnites sepultus*; suborbicular, rather irregular, convex; auricles unequal; costae ten, equal, radiating, waved, small and crenulated, degenerating towards the ventral border into mere lines; interstitial spaces wide, each having one or two longitudinal lines; length $\frac{1}{4}$ inch.

141. *Plicatula elongata*; elongated, rather oblique; costae longitudinal, waved, very fine, closely arranged, rounded and scabrous, terminating towards the tubular border in a few tubular spines.

143. *Placuna armata*; the normal form is that of curved radiating lines of tubular spines little elevated, but the general aspect is that of irregular elevated confused tubercles. This species is placed under *Placuna* merely to indicate that generically it agrees with the shell called *Placuna jurensis*, but which certainly is neither a *Placuna* nor yet an *Anomia*, to which latter genus it has sometimes been assigned; its true place must remain for the present in abeyance.

144. *Placuna? complicata*; surface covered with clusters of tubular spines, depressed and confused, producing a most irregular and uneven surface.

148. *Mytilus subrectus* ; elongated, smooth, slightly oblique, anterior border straight, the two extremities of the shell attenuated ; hinge-line lengthened, straight.

150. *Mytilus crenatus* ; thick, oblique, convex ; length less than twice the width ; striæ regular, concentric, deeply grooved upon the back ; a single depression or fold (its edge acute) passes obliquely from the umbo to the antero-ventral border ; hinge straight, moderately long.

151. *Dreissena lunularis* ; smooth, anterior border straight or slightly concave, posterior side curved, umbones pointed, terminal, longitudinal ridge acute, anterior diameter through both valves equal to the breadth.

152. *Gervillia tortuosa* ; this shell, the *Gastrochæna tortuosa* of Phillips, belongs to a very remarkable section of the *Gervillia*, of which *G. Hartmanni* and *G. Monotis* are likewise examples ; they are tortuous, very inequivalve, the right valve being more or less concave, its borders fitting closely to the undulations of the convex valve.

154. *Gervillia aurita* ; equivalve, smooth, very oblique, both the auricles very much extended and acuminate, the entire figure being very slender.

156. *Gervillia lævigata* ; smooth, very oblique ; anterior auricle produced and rather pointed, posterior moderately large ; left valve convex, right nearly flat. This shell is more oblique than *G. costatula*, and wants the ribs of that species.

159. *Pteroperna* ; a group of shells proposed to be separated from the *Gervillia* and *Perna*, to both of which genera they possess affinities, combined with the external form of *Avicula*. A species very nearly allied to our *P. gibbosa* is abundant in the Great Oolite ; our shell however is more convex and oblique.

161. *Pinna hastata* ; spear-shaped, compressed, lines of growth waved and strongly marked ; lines longitudinal, delicate, waved and closely arranged, crossed by others more distinct.

164. *Hiatella interlineata* ; subquadrate ; anterior side rounded, posterior straight and truncated ; costæ transverse, large, few, elevated, forming an angle upon the back of the shell ; the interstitial spaces have numerous encircling very fine lines.

169. *Opis angustatus* ; narrow, elongated, extremely convex, fornicated ; lunule large, posterior depression cordate, large and deep, with a wide longitudinal sulcus posterior to the carina ; ribs concentric, closely arranged, posterior side with densely arranged fine transverse lines ; carina moderately elevated and impressed by the costæ ; umbones narrow and incurved.

171. *Opis gibbosus* ; subtrigonal or cordate, convex, anterior side and base nearly straight ; umbones large, dorsal carina obtuse and scarcely elevated ; costæ large, both upon the anterior and posterior side ; lunule cordate and deep, inner margin toothed. The nearly globose form, nearly obsolete carina, and ribs upon the posterior side, separate it from contemporaneous species. The size does not usually exceed that of a pea ; with increase of growth it becomes more trigonal.

176. *Trigonia costatula* ; transversely oblong, anterior side trun-

cated, flattened, with two obscure longitudinal ridges crossed by numerous lines; dorsal ridge nodulated, but little elevated; dorsal costæ disunited from the carina, numerous, regular, narrow and curved. With advance of growth the anterior transverse lines become indistinct; the dorsal ribs are broken in their anterior portions and displaced, forming irregular nodules; this change commenced when twelve ribs had been perfected, but the Leckhampton specimens not having that number, do not exhibit it.

177. *Trigonia* v.- *costata*; semiorbicular, anterior side slightly concave, with a single deep longitudinal groove and numerous transverse prominent lines, prominent near the umbo, but becoming fine and indistinct afterwards; area lanceolate; dorsal carina narrow, smooth, but little elevated; dorsal costæ numerous, closely arranged, angular and narrow, partially broken in the middle, and forming an acute angle with their anterior portions; at the middle they also become slightly nodulated.

178. *Corburella*, new genus.

Gen. Char. Equivalve, inequilateral, transverse, thin, smooth; umbones small, approximate, posterior side attenuated and slightly gaping, anterior side more convex and rounded; hinge with a small depressed subconical cardinal tooth in each valve, and an extended slightly thickened laminar plate forming a kind of anterior lateral tooth or process; muscular impressions faintly marked, scarcely visible.

This genus differs from *Corbula* in being equivalve, and in the character of the hinge, the teeth are much smaller and not hollowed to receive the ligament; the substance of the test is thinner, and the muscular impressions much more faintly marked. The *Corbula curtansata* of Phillips is the type of this genus.

179. *Corbula imbricata*; shell suborbicular, small, slightly longer than wide, imbricated by a few elevated concentric ridges rising over each other; lunule cordate, excavated; umbones incurved: the largest specimens attained the size of a small pea.

177. *Trigonia tuberculosa*; ovately trigonal, depressed, fornicated; anterior side flattened, transversely striated; carina acute, elevated and crenated; ribs regular, curved and tuberculated, tubercles elevated, obtuse, very closely arranged, their upper surfaces flattened.

184. *Cardium semicostatum*; ovately convex, rather longer than wide; umbones prominent, mesial, incurved, posterior side ribbed longitudinally; ribs smooth, rounded, closely arranged, occupying about one-fourth of the surface; the remainder smooth in the adult state, but young individuals have very fine, closely arranged, concentric striae.

183*. *Cypricardia siliqua*; transversely elongated; umbones small, anterior; hinge-line very long, posterior side extended and attenuated, ventral border straight, lines of growth few.

187. *Cardium lævigatum*; suborbicular, smooth, transverse, moderately convex; umbones mesial, incurved, anterior side rounded, posterior slightly truncated, ventral border rounded, lines of growth few and obscure.

189. *Cardium punctato-striatum*; oblong, transverse; umbones anterior; anterior side short, rounded, posterior lengthened and obliquely truncated, ventral border curved; striæ longitudinal, numerous and closely punctated, crossed by obscure numerous encircling lines giving the surface almost a scabrous aspect; there is likewise an obscure oblique posterior longitudinal keel, posteriorly to which the surface is much more depressed.

195. *Cytherea picta*; suborbicular, rather longer than wide, smooth, moderately convex; umbones mesial, slightly curved forwards; hinge-margin oblique, curved; ventral border rounded; surface with several broad zones of colours at irregular intervals, the bands being white upon a chocolate-coloured ground; length $\frac{1}{2}$ inch: rare.

197. *Astarte quadrata*; quadrate, transverse, thick, rugose, lines of growth irregular and strongly marked, forming an angle somewhat rounded upon the posterior side of the shell; umbones anterior, lunule excavated, cordate.

198. *Astarte bullata*; small, subglobose; umbones mesial, curved forwards; lunule excavated, cordate; costæ elevated, broad, rather distant, usually, but not always, regular; size that of duck shot.

199. *Ptychomya Agassizii*; new genus indicated, but not described, by M. Agassiz: see a notice of this genus at page 408.

201. *Astarte Menkei*; our specimens do not exhibit the wrinkled surface near to the umbones described by Dunker, but this probably is an inconstant character.

203. *Astarte formosa*; rather depressed, transversely ovate; umbones pointed, mesial, inclined forwards; lunule large, slightly excavated; hinge-line lengthened, oblique; anterior border rounded, posterior rather produced and slightly angulated; encircling ribs very closely arranged, irregular, small, and little elevated; length equal to $\frac{1}{4}$ ths of the breadth.

205. *Corbis aspera*; transversely oval, gibbose; umbones large, mesial; lunule small, cordate; hinge-line straight, sloping, borders rounded, inner margin toothed; encircling costæ narrow, elevated, rather distant; interstitial spaces with fine encircling striæ. This species approaches near to *Corbis Lajoyei*, D'Archiac, but the ribs are more elevated and distant, the umbones are larger, and the hinge-line is not so nearly horizontal.

207. *Corbis levigatus*; small, transverse, moderately convex; umbones mesial, lunule small; hinge-line straight, nearly horizontal; costæ few, widely separated, elevated, the interstitial spaces smooth; length $\frac{1}{2}$ inch, breadth $\frac{1}{4}$ th more.

211. *Panopæa delicatissima*; small, transverse, oblong, convex; umbones large, mesial; hinge-line rather straight; ventral border lengthened, rather straight; costæ concentric, regular, closely arranged, delicate; length $\frac{1}{2}$ inch: breadth $\frac{1}{4}$ inch; the hinge has not been seen.

204. *Lucina lyrata*; the abundance of this species, its wide diffusion and great variety of aspect demand something more than a mere notice of its occurrence. The two extreme varieties are as follows:—

Var. 'a.' shell orbicular, moderately convex; hinge-line oblique, short and curved. Var. 'b.' shell transversely ovate, rather flattened; hinge-line straight, lengthened and nearly horizontal; the character of the surface, though variable, has nothing peculiar to either variety of figure; the encircling costæ are narrow, elevated, widely separated and never quite regular; the interstitial spaces have numerous encircling lines, which are serrated or indented, forming a finely granulated surface; there is also occasionally an obscure rib to be traced within them; the posterior side has an oblique longitudinal fold, posterior to which the shell is more compressed, and the costæ curve nearly at right angles to the other surface; the posterior border is likewise slightly truncated and angulated at its junction with the ventral border.

217. *Ceromya striata*, syn. *Cardita striata*, Sow. Min. Con. t. 89. f. 1, but not *Isocardia striata*, Roemer, t. 7. f. 1, which is likewise a *Ceromya*, and of which latter shell *Ceromya inflata*, Agassiz, is a synonym. The present or Sowerby's species has the striæ longitudinal, in the other they are transverse.

212. *Tancredia donaciformis*; transverse, subtrigonal, smooth, moderately convex; umbones mesial; posterior border slightly concave, posterior extremity rather pointed, anterior border straight, obliquely sloping, ventral border rounded; length $\frac{3}{4}$ ths the breadth.

113. *Tancredia sulcata*; small, transverse, subtrigonal or donaciform; umbones mesial, surface very finely striated concentrically with an anterior dorsal longitudinal ridge grooved at the angle; the striæ anterior to the sulcus rise at a right angle with the others.

228. *Cucullæa amœna*; rhomboidal, fornicated; umbones large, mesial, distant, both extremities of the hinge-line angulated; posterior dorsal ridge acute, the surface posterior to it concave; there are also several irregular longitudinal ribs upon each side of the shell; the middle portion of the surface has only encircling striæ.

224. *Arca rudiusecula*; transversely elongated; width $2\frac{1}{2}$ times the length; borders elliptically curved; a wide longitudinal mesial depression; longitudinal costæ irregular and rugose, nearly evanescent upon the middle portion.

250. *Modiolarca ovata*, syn. *Arca ovata* (Buckman); oblong, ovate, very gibbose; umbones anterior, very large, touching each other; hinge-line curved, its extremities rounded; ventral border sinuated by a wide mesial depression, but which does not reach the umbones; surface imbricated with longitudinal closely arranged waved and flattened costæ, crossed by densely imbricated transverse lines; lines of growth few and strongly marked. The diameter through the umbones is equal to that of the shell longitudinally. The general figure is nearly that of a very gibbose *Modiola*, but the character of the surface agrees with that of the *Arcacea*.

231. *Cucullæa triangularis* (Phillips?); subtrigonal, rather flattened; hinge very oblique to the ventral border, and nearly at right angles to the posterior border, which is straight and elongated; anterior border much shorter, rounded; umbones oblique, nearly mesial; surface with exceedingly fine decussating striæ producing a finely gra-

nular surface. The figure agrees with the shell figured by Phillips ; the greater number of specimens do not exhibit any markings upon the surface.

233. *Cucullæa nana* ; minute, rather compressed, suborbicular ; umbones mesial, touching ; hinge-line short, rounded at the extremities ; surface with extremely fine decussating lines, two or three of which upon the posterior side are more elevated.

249. *Cucullæa bipartita* ; small, rhomboidal ; umbones large, mesial ; hinge-line angulated at its extremities ; a longitudinal oblique keel upon the posterior side, and a wide and deep depression extending from the umbo to the ventral border ; surface with lines longitudinal, closely arranged, crossed by a few lines of growth.

234. *Lithodomus attenuatus* ; elongated, smooth, posteriorly attenuated ; umbones small, near to the anterior extremity ; width $\frac{3}{4}$ ths of an inch, which is thrice the length.

248*. *Cucullæa obliqua* ; depressed, oblique, subtrigonal ; umbones touching, small, mesial ; hinge very oblique to the ventral border ; anterior side short, rounded ; posterior produced, flattened and angulated at the base ; surface with extremely fine lines, both longitudinal and transverse, the latter very densely arranged. There may sometimes be difficulty in distinguishing this from *Cucullæa cucullata*, but the present shell is more flattened and oblique, the umbones are much smaller, the hinge-line shorter, and the posterior border more lengthened.

172. *Trigonia clavo-costata* ; shell elevated, anterior border rounded ; costæ regular, some tuberculated, others smooth ; tubercles large, closely arranged, the first three or four and the last one or two elevated, but without tubercles ; cardinal area broad, flattened, with oblique carinæ ; posterior extremity short and truncated. This shell has usually been confounded with *T. clavellata*, but the figure is much more truncated or shortened posteriorly, the costæ are perfectly regular, and the tubercles are very large and closely arranged, the few first and last costæ being simple ; these several features separate it from the Oxford clay species. It approaches near to *T. Bronnii*, Agassiz, in form, but the character of the costæ as above described are different.

A Stratigraphical Account of the Section from Round Tower Point to Alum Bay, on the North-west coast of the Isle of Wight. By THOMAS WRIGHT, M.D.

READ 17TH SEPTEMBER 1850.

THE publication of Cuvier and Brongniart's celebrated '*Description Géologique des Environs de Paris*' formed an important epoch in the history of geology in general, and of the tertiary system of the Isle of Wight in particular. The appearance of this work induced the late Mr. Thomas Webster, Secretary to the Geological Society of London, to make in 1813 a minute examination of the structure of the island, with the view of comparing the beds at Headon Hill with those described by the French naturalists in the environs of Paris. He adopted the classification of these authors, and divided the coast section at Alum Bay in a descending order into—

5. Upper freshwater formation.
4. Upper marine formation.
3. Lower freshwater formation.
2. London clay.
1. Sands and plastic clay.

In 1816 Sir Henry Englefield published his splendid work on the Isle of Wight, which contains numerous coast sections most accurately drawn by Mr. Webster, together with a series of letters by the same accurate observer written from the island whilst on a tour made expressly for collecting materials for Sir Henry's work.

In 1821 Mr. G. B. Sowerby visited Headon Hill, to collect fossil freshwater shells for the illustration of Férussac's great work on '*Land and Freshwater Mollusca*,' and to obtain a regular series of the strata above the chalk. He published a criticism* on Mr. Webster's paper, in which he dissented from many of that author's descriptions, but especially from that part which related to the upper marine formation. He described what he supposed to be a mixture of shells belonging to freshwater and marine genera in this bed, and inferred therefrom its estuary and not its marine origin as stated by Webster. He pointed out

* *Annals of Philosophy*, vol. ii. 1821, p. 216.

the existence of fossil shells and *Septaria* in the brown clay beneath the coloured strata.

In 1822 Prof. Sedgwick published * a paper on the geology of the Isle of Wight, in which he confirmed the general correctness of Mr. Webster's descriptions. He noticed that the fossils in the brown clay differed from those figured in Brander's '*Fossilia Hantoniensia*.' He described the tertiary strata on the north side of the island, which he stated belonged to the lower fresh-water formation, and gave a sketch of the beds from Studland Bay to Hordle on the coast of Hampshire, which he compared with beds in the Isle of Wight.

In 1838 Mr. Bowerbank published a paper † on the section at Alum and White Cliff Bays, and gave measurements of the different beds exposed in these coast sections. He likewise showed that the rich shelly sands of Bracklesham Bay had their equivalents in the White Cliff Bay section.

In 1846 Mr. Prestwich published ‡ his valuable paper on the tertiary formations of the Isle of Wight, in which he drew a comparison between the beds at White Cliff and Alum Bays, and compared the relative ages of the English beds with those of the French tertiary system.

None of the works above cited contain an account of the section which forms the subject of our paper. This appears to be the more remarkable, as the analysis of the different beds composing it affords the best key to a knowledge of the true relations of the lacustrine series with the intercalated fossiliferous zones of estuary and marine shells. Indeed I cannot understand how a correct knowledge of these beds can be obtained in any other way. The fact that they have hitherto been studied at Headon Hill alone, is to my mind a sufficient reason why such a variety of opinions prevail regarding them.

With the view of settling to my own satisfaction the question "whether an upper marine formation actually existed," as the fact appeared doubtful from the way in which it had been alluded to by previous observers, I determined to study the beautiful coast section from Round Tower Point to Alum Bay, and take each bed in succession as it rose from the shore, measure its thickness and note its contents. By this means I hoped to ascertain the genera of shells that were naturally associated together in each of the beds, and thereby to arrive at a true solution of the problem. In this investigation I experienced much difficulty, from the extensive founders (or falls) that have taken place in different parts of the section, as well as from the varia-

* *Annals of Philosophy*, vol. iii. 1822, p. 329.

† *Trans. of the Geol. Soc. Lond.* vol. vi. Second Series, p. 169.

‡ *Quart. Journ. of Geol. Soc.* vol. ii. p. 223.

tions in the thickness of the beds in different parts of their course. This fact of local activity during the deposition of these strata forms an interesting feature of our English tertiary system.

It admits of demonstration in several of the minor groups, but becomes strikingly evident when we compare the section at White Cliff with that at Alum Bay, where the difference in thickness amounts to upwards of 300 feet in the entire series. This fact accounts for the difficulty experienced in making measurements of the same beds tally at different points, and therefore our figures must be received only as approximations to the truth. During the accumulation of these strata, irregular local action was going on at very short distances apart, as proved by the diversity which exists between our section and the equivalent beds in the Hampshire basin, and shows how necessary it is, in the study of our tertiary system, to multiply observations upon the individual beds in different parts of their course, and not to confine our observations to one section alone.

The beds may be classified into—

1. Lacustrine.
 - a. Upper freshwater.
 - b. Lower freshwater.
2. Estuary.
Intercalated with the above.
3. Upper marine.
4. Lower marine, divisible into—
 - a. Barton series.
 - b. Coloured sands and clays.
 - c. Bognor series.

The *lacustrine* strata contain the genera *Paludina*, *Lymnæa*, *Planorbis*, *Melania*, *Melanopsis*, *Cyclas*, *Potamomya*, *Unio*.

The *estuary* strata contain *Potamides*, *Melanopsis*, *Melania*, *Natica*, *Nerita*, *Neritina*, *Cyrena*, *Mytilus*, *Ostrea*, and *Serpula*.

The *marine* strata contain *Ancillaria**, *Voluta**, *Natica*, *Bulla**, *Murex**, *Cancellaria**, *Rostellaria**, *Fusus*, *Cytheræa**, *Psammobia**, *Mactra**, *Mytilus*, *Ostrea*, *Balanus**, *Serpula**.

I rarely found estuary shells mixed with the true lacustrine genera, but occasionally a few *Lymnæa* or *Paludina* were found in an estuary bed. *Cyrena* and *Potamides* seem to have been common to beds of estuary and marine origin; the true marine genera marked (*) are limited to the marine formations.

If the premises upon which the argument is based be correct, it follows that many changes of condition took place during the deposition of the lacustrine series, as there are several intercalations of estuary genera between the true lacustrine beds both in the upper and lower formations.

The transition from the lower freshwater to the upper marine is made by a series of beds containing estuary species, and the passage from the marine to the upper freshwater is in like manner made by several zones of estuary shells. The association of the genera in the manner described is very decided. I feel satisfied that the contrary opinion has arisen from observers having collected specimens from the foundered beds on the shore instead of from the strata *in situ*.

The beds rise very uniformly at angles varying from 1° to 5° to the horizon, and incline to the east. Their continuity is interrupted by four chines and one ravine: commencing from the north and proceeding southwards are the following chines, Lynchen, Bramble, Colwell, and Weston. The ravine separates the Barton series at Alum Bay from the lower freshwater beds; down this gorge a pathway leads from the rabbit warren to the shore. The chines are formed by streamlets whose waters in their course to the sea have cut down the clays and marls to the beach.

The observer is supposed to walk from Sconce to Colwell and Tollands Bays along the shore, thence round Headon Hill to Alum Bay, and to study the beds as they rise from the shore and ascend into the cliff.

The strata appertaining to the upper freshwater formation around Sconce Point have experienced much disturbance and are in a state of ruin. The hill forms an uneven slope, and is much rent by the breaking up of the clays and marls of which it is composed; it is covered with grass and foliage almost to the water's edge.

From some blocks of limestone near the shore I obtained *Bulinus ellipticus*, *Paludina angulosa*, and *Planorbis*.

These fossils are denuded of their shell. The clays and marls that form the upper part of the hill above the Coast-guard station at Sconce Point contain freshwater shells in a fragmentary state.

No. 1. The first bed *in situ* is a band of blue clay which rises on the shore at a point nearly opposite to Hurst Castle, and where Worsley's Tower formerly stood. It exhibits many shelly laminae. *Potamomya plana* is in great profusion in this bed. It rests upon slate-brown, rusty, and variously coloured clays, in which *Paludina*, *Cyclas*, *Potamomya* lie in zones. It is inclined at an angle of about 2° , and measures about 15 feet. The line of elevation has been much disturbed, and the angles which the bed makes are various at different points; it disappears south of Cliff End.

No. 2. I regard as a brackish water series. It consists of bands of bluish or slate-coloured clays with zones of *Cyrena ob-*

ovata of large size; *C. cycladiformis*, *Potamides margaritaceus* in great profusion and perfection. It rises on the shore north of Cliff End, at a short distance from No. 1; its line of demarcation from that bed is well defined by the thick fossiliferous band of *Cyrena obovata*. I observed in this bed a few *Cytherea incrassata*. It ascends at angles from 5° to 10°, and runs out on the cliff north of Lynchen Chine; it measures upwards of 21 feet, and contains *Melanopsis fusiformis*, small *Serpula*, and a small-ribbed *Modiola* of the same species as that found at Hordle.

No. 3. Lymnean limestone (No. 1); this rock contains hard nodules which fall out on the shore, and much oxide of iron. It is full of *Lymnæa* and *Planorbis*.

A ledge formed of this bed stretches across the Solent towards Hurst Castle. It rises on the shore at Cliff End, and blocks of it are seen along the strand, from which good specimens with their shells may be obtained. It measures about 3 feet, and is interstratified with bands of blue clay.

No. 4. Yellow sand rises at the south of Cliff End: its origin is concealed by the debris of the brackish series above. This bed is well seen in the cliff between Lynchen and Bramble Chines, and again at Warden Point.

It contains few shells, and measures under Long's House 24 feet. It attains its greatest development at Headon Hill, where it passes into a light-coloured calcareous rock, richly fossiliferous, with *Lymnæa* and *Planorbis* above, and small univalves and *Melania* below.

No. 5. Laminated sandy clays, with sandy seams between the layers of a slate colour, and containing much iron which stains the surface of the bed. They rise to the south of Lynchen Chine and pass out beyond Warden Point, underlying the yellow sand, and contain several fossiliferous seams. The following section is taken at Warden Point:—

Gray clay striped with fawn and red	4 feet.
Gray sand	1 foot.
Sand striped gray, blue and red	4 feet.
Slate-coloured clay, with a band of <i>Cyrena obovata</i> .	6 inches.

Potamomya plana is found in great abundance and perfection in this bed. The fossiliferous seams are confined to the upper and lower laminæ. The lower strata contain many shells, and form a well-marked band between this bed and No. 6. As it passes through the cliff between Lynchen and Bramble Chines, it inclines at an angle of 1°. Between Bramble and Warden Point the angle increases to about 3°.

At Headon Hill this bed is very fossiliferous, and contains

there *Cyrena obovata* in great profusion in a black clayey matrix with lignite and much vegetable debris.

From the sandy seams at Bramble Chine I collected many hazel-nuts in a good state of preservation.

No. 6. Underlying the *Potamomya* bed is a band of firm bluish green sand, tolerably compact. This appears to form the transition bed to the estuary series below it. It rises on the shore 1620 feet north of Bramble Chine, forms a prominent belt in the cliff, and in some places a ledge, by the foundering of the superincumbent clays and sands: measures about 3 feet, and is overlaid by laminated clay rich in *Potamomya*.

No. 7. Blue clay with few fossils, 3 feet.

No. 8. Bands of nodular ironstone resting on blue sandy clays; rises 55 paces south of No. 6, and runs out at Warden Point. Beautiful slabs of this bed from 4 to 5 inches thick lie along the shore, and in most of the cottages household specimens may be seen. The clays and nodules contain *Cyrena obovata*, *C. cycladiformis*, *Potamides margaritaceus*, *P. cinctus*, *Cytherea incrassata*; *Melanopsis*, *Nematura*, as in the *Neritina* bed. This ferruginous bed measures about 20 inches.

No. 9. Gray mottled sands, without shells, 18 inches.

No. 10. Dark stiff tenacious clay. This is a very rich bed, and many of the shells which are of estuary origin are beautifully preserved.

It rises on the shore about 100 paces to the north of Lynchen Chine, is nearly horizontal for a considerable distance, and is much covered by debris, but is seen *in situ* beyond Bramble Chine. It is lost at Colwell and reappears in the cliff at Warden Point, passing out a short distance beyond.

I collected from this bed *Cyrena obovata*, *C. cycladiformis*; *Mytilus affinis*, in great abundance; *Ostrea*, two species; *Cytherea incrassata*, *Potamides margaritaceus*, *Melania muricata*, *M. fasciata*, *M. costata*, *Melanopsis fusiformis*, *Fusus labiatus*, *Nerita aperta*, very few of *Neritina concava*, and *Natica depressa*. It measures about 3 feet.

No. 11. A dark-coloured stiff clay, without shells; measures 18 inches, with a shelly band of blue clay 6 inches in thickness, containing the same genera and species as No. 10, with nodules of ironstone in some parts of its course. These two beds indicate an estuary condition during the period of their deposition.

No. 12. "The *Ostrea* bed" rises on the shore at the south side of Lynchen Chine, is much foundered at its origin, but is well seen *in situ* in the walls of Bramble Chine, in the escarpment south of that gorge, in the cliff at Warden Point, and at Alum Bay, high up on Headon Hill.

In Colwell Bay the foundering of this bed has produced three great masses of oyster-shells which project from the side of the cliff. At first sight they give the observer the idea that they were oyster beds wedged in between the Venus bed which they entirely obscure; but it is not so; they are in fact produced by the falling of the oyster band over the inclined face of the lower beds; the sandy matrix with the oyster-shells having fallen over in a semifluid state. The *Ostrea* bed measures from 18 inches to 2 feet in thickness. The shells are so closely packed together that perfect specimens are obtained with much difficulty.

Besides *Ostrææ* of two new species in great abundance, I collected here *Mytilus affinis*, *Potamides margaritaceus*, *P. cinctus*, *Fusus labiatus*, *Balanus*, and *Serpula*.

No. 13. Laminated blue clay mottled with red, non-fossiliferous: 18 inches.

No. 14. "The Venus bed" rises on the shore 484 feet south of Lynchen Chine, and runs out on the cliff at Tollands Bay near the Coast-guard station. Between Weston Chine and the lower flank of the north side of Headon Hill, there has been extensive denudation. The Lymnæan limestone and the upper marine have been entirely removed. These beds reappear in Headon, and the Lymnæan limestone with its underlying beds form a fine bold mural wall, which stands out from amongst the ruins of the softer strata on the north side of that hill. The Venus bed reappears near the summit of the south-western escarpment of Headon Hill.

This interesting bed ought to be studied in Colwell Bay, where it is best developed, and from whence the finest specimens of its beautiful fossils are obtained. At the base of the Venus bed is a thin band of clay, containing *Psammobia compressa* in great perfection. The finest specimens are obtained at low-water mark, when a ground sea has removed the sand. Here likewise we find *Ostrea*, two species undescribed, in considerable abundance. Above the clay-band is the true upper marine or Venus bed; it consists of a slate-coloured siliceous sand mixed with clay. The shells, which are very abundant, lie for the most part on their sides, but I have found them inclined in all directions. This bed appears to have been a slow and tranquil deposit from sea water along a sandy shore. The shells are as perfect in all their parts as recent specimens, and the peculiar nature of the matrix has so preserved their colours, that one almost doubts the fact of their being fossil shells.

I collected from this bed the following shells:—

Actæon.
Ancillaria subulata, Lam.
Buccinum desertum, Brand.

Balanus reflexus, Sow.
— *unguiformis*, Sow.
Cancellaria muricata, Wood.

Cancellaria elongata, Wood.
Cerithium —.
Corbula cuspidata, Sow.
Cyrena cycladiformis, Desh.
 — *obovata*, Sow.
Cytherea incrassata, Desh.
 — *obliqua*, Desh.
Fusus labiatus, Sow.
Lucina —.
Macra, new species.
Melania fasciata.
 — *muricata*.
Melanopsis ancillaroides.
 — *fusiformis*.
Mya angustata, Sow.
Natica depressa, Sow.
 — *epiglottina*, Lam.
 — *labellata*, Lam.
Nucula similis, Sow.

Nucula, new species.
Oliva, new species.
Ostrea, two new species.
Panopæa corrugata, Edwards.
Pleurotoma semicolon, Sow.
 —, two new species.
Psammobia compressa, Sow.
 — *solida*.
Serpula corrugata, Sow.
 —, new species.
Rostellaria rimosa, Brand.
Voluta spinosa? Sow.
 —, new species, like *V. harpa*,
 Desh.

PISCES.

Teeth of *Squalus*.
 Teeth of *Myliobatis*.

The Venus bed measures from 7 to 8 feet in thickness: the lower half is a slate-coloured sand; the upper half in some parts of its course is ferruginous. It is from the lower zone that all the fine shells are obtained; those found in the upper zone are brittle and colourless.

The term "upper marine formation" is only strictly applicable to the oyster and Venus beds with the intercalated band of non-fossiliferous clay.

No. 15. The next series of beds are of estuary origin. They consist of alternations of sand and clay, with seams of *Potamides*, *Neritina*, *Melanopsis*, *Natica*, *Cyrena*, *Mytilus* and *Ostrea*. The following section gives the order of these deposits, which are well exposed in a break in the cliff beyond Long's Cottage:—Pea-green coloured sands with a thin band of *Cyrena obovata*, about 3 ft. Shelly band in a dark clayey matrix, containing *Cyrena obovata*, *Potamides margaritaceus*, *Melania muricata*, and *M. fasciata*, 4 inches. Gray, green, and yellow sands, no shells, 2 feet 4 inches. Shelly band in a dark clay containing *Cyrena obovata*, *Potamides* and *Ostrea*, 4 inches. Sandy clay striped gray, green and ochre, no shells, 2 feet 9 inches. Shelly band with a seam of lignite at the base and *Cyrena obovata* piled upon each other, 6 inches.

The origin of these beds on the shore is seen south of Bramble Chine, but it is much concealed by the ruin which has fallen upon them. The upper marine in Colwell Bay forms an undercliff, the wall of which is the Venus and oyster bed and upper estuary series, and its terrace, the ledge of Lymnæan limestone hereafter to be described. These fossiliferous bands have foundered much at Warden Cliff, where they run out. They reappear *in situ* in Headon Hill, and pass round into Alum Bay. I traced them into the western escarpment of Headon; the beds here are

very fossiliferous, and contain immense numbers of *Potamides ventricosus* and *Cyrena obovata*.

The shelly blocks on the shore containing these elegant shells are derived from the debris of these beds.

No. 16. "The Neritina bed." The origin of this bed on the shore is concealed by debris; it is seen however at low-water mark below Bramble Chine when a ground sea has cleared away the sand.

This bed is seen well *in situ* beneath the flagstaff at Cliff Cottage reposing upon the fossiliferous bands of No. 15. It inclines at an angle of about 2° . Here it is a rich fossiliferous seam about 18 inches in thickness, divisible into three shelly zones. The inferior zone contains *Potamides margaritaceus*, *P. cinctus*, *Melania muricata*, *Melanopsis minuta*, *M. fusiformis*, and myriads of *Nematura* of a new species.

The middle zone contains *Neritina concava* in great abundance, and in a high state of preservation, with all their delicate-coloured pencillings, like recent shells: along with these which characterize the bed, are, *Potamides margaritaceus*, *P. cinctus*; *Nematura*; *Melanopsis fusiformis*, *Serpula tenuis*, *Cyrena cycladiformis*; vegetable impressions and seeds of *Chara medicagimula*, and *C. tuberculata* (*Gyrogonites*).

The upper zone contains *Natica depressa*, *Mytilus affinis*, *Ostrea*, new species, and a profusion of *Cyrena obovata*.

The Neritina bed at Headon Hill is charged with lignite, black clay and vegetable remains, but I collected its characteristic fossils at the western escarpment.

No. 17. Blue sandy clay measuring from 4 to 9 feet ? in thickness in different parts of its course, and containing fossiliferous seams in its upper and lower laminæ ?

The upper shelly band contains *Cyrena obovata* and *Potamides margaritaceus*. In the lower layers, *Lymnæa longiscata* was observed to occur in a crushed state sparingly.

No. 18. Lymnæan limestone (No. 2) forms a conspicuous bed in this section. It rises on the shore about 390 feet north of Colwell Chine, and inclines at an angle of about 3° . It runs out on the cliff near the flagstaff of the Coast-guard station beyond Warden Point. It has been denuded from the cliff in the centre of Tollands Bay. It appears *in situ* at the north side of Headon, and with the underlying clays and sands forms the prominent mural band which runs nearly horizontal through the northern slope of that hill. At its southern escarpment, where it overlooks Alum Bay, it forms a well-defined bed. Its inclination here increases, and it is suddenly curved up together with the under- and the overlying beds to an angle of 20° , and soon after abruptly ceases.

This limestone band is not uniform in structure throughout its course. It is of a pale yellow cream colour in some places, dense and compact or light and porous in others. It varies in thickness from 3 to 6 feet, and its compact varieties are used for building purposes.

How Ledge is formed by this bed stretching under the Solent ; and the rocks at Warden and Alum Point are foundered blocks of Lymnæan limestone. It is very fossiliferous throughout its entire course. The shells are beautifully preserved : as they drop out of the rock they leave cellular cavities ; the interior of the shell being filled for the most part with a more spongy material than that which connects the individual fossils with one another.

It is impossible to describe the beauty of some of the rocks lying at Warden Point, which appear to be little else than a mass of freshwater shells cemented together by a calcareous matrix.

The elegant forms of the snow-white shells make a chaste contrast with the yellow rock in which they are imbedded. With a chisel and a light hammer the following specimens may be obtained in great perfection :—

Lymnæa longiscata.

— *fusiformis.*

— *columellaris.*

— *pyramidalis.*

— *minima.*

— *maxima.*

Planorbis euomphalus.

— *lens.*

— *rotundatus.*

— *obtus.*

Bulimus ellipticus.

I regard this bed as the uppermost of the lower freshwater formation.

No. 19. Fawn-coloured sandy clay, with bands of *Paludina unicolor* in the upper layers ; the lower layers are not so fossiliferous : measures 6 feet.

No. 20. Bluish gray sands, no fossils : measures 3 ft. 6 inches.

No. 21. Blue clay with several seams of shells. *Paludina* and *Melania* are very abundant, and fine specimens of *Unio Solandri* are obtained in good preservation, together with bones of *Palæotherium* and *Trionyx*, and a profusion of small black seeds, *Carpolithes ovulum*, Brong., *C. thalictroides*, Brong. It rises south of Colwell Chine. A good section of the bed may be seen at Warden Point : measures 2 feet 6 inches.

No. 22. Striped clays, gray and bluish, with rich seams of shells, in which *Paludina* and *Melania* are most abundant : measures from 6 to 8 feet.

No. 23. Grayish white sand rises on the shore near Warden Point, passes through the upper part of Weston Chine, and is seen capping the hill south of that gorge ; it reappears again beneath the Lymnæan limestone on the north side of Headon ; here it

passes into a firm rock, and is seen *in situ* in the southern escarpment. It preserves the same angle of inclination as the Lymnæan limestone.

At its origin, the first 8 feet of this bed is a pure sand rock with thin seams of freshwater shells (*Paludina*, *Lymnæa*, *Cyclas*). Below this the bed contains large oblong nodules, chiefly composed of shells, mostly in a fragmentary state; from these I collected—

Paludina lenta.

Lymnæa longiscata.

— pyramidalis.

Planorbis euomphalus.

Planorbis rotundatus.

Melanopsis fusiformis.

Cyclas exigua.

The lower laminæ of this bed contain greenish-coloured sands full of *Paludina*. This bed changes its physical character in different parts of its course. In Headon Hill it is calcareous, and contains a few angular pebbles with two layers of hard siliceous nodules, one in the middle and the other at the bottom of the bed. It is here likewise distinguished by the same group of fossils. As it stretches across the Solent it forms that dangerous reef called Warden Ledge, over which a buoy is anchored: it measures about 20 feet. In Headon Hill escarpment this bed admits of several subdivisions.

No. 24. Olive-green clay, stiff and tenacious, with numerous layers of *Potamomya plana* and *Melania*. It rises on the shore to the north of Weston Chine, and can be traced *in situ* to a considerable distance: measures 1 foot, and rests upon a band of lignite, in which the vegetable structure is well preserved; measures 6 inches.

No. 25. Bluish sandy clay with few fossils in its upper part, but full of *Potamomya plana*, *Paludina* and *Lymnæa* below: measures 2 feet 6 inches.

No. 26. Lymnæan limestone, No. 3, rises on the shore a few paces north of Weston, forms a thin ledge at its origin, and contains *Lymnæa* and *Planorbis* in abundance: measures from 10 to 18 inches.

No. 27. Dark olive-green, marly clay, rises below the preceding Lymnæan limestone; it contains seams of *Lymnæa*, *Paludina*, and *Potamomya*, which prevail most in the lower layers: measures about 10 feet?

No. 28. Light-coloured calcareous marl. It caps No. 29, and forms a ledge over which the water falls in Weston Chine; contains *Lymnæa* and *Planorbis*, and measures 9 inches.

No. 29. Fine gray sand, rises on the shore about 120 paces north of the boat-houses by Weston Chine. This bed is well exposed in that ravine: measures 2 feet 4 inches, and is underlain by a band of lignite about 7 inches thick.

No. 30. Dark olive-green clay, with a band of *Lymnæa* and *Planorbis* in its upper part, and masses of nodular ironstone below. Several of these have rolled out of the bed and lie on the shore at Tollands Bay : measures 4 feet 6 inches.

No. 31. Grayish white sand, rises on the north side of Weston Chine ; is exposed at the base of that ravine, is covered up with grass in the remainder of its course through Tollands Bay, and concealed by debris on the north side of Headon. It is seen however *in situ* on the southern escarpment of that hill. The anticlinal axis figured by Webster in his coast section of Tollands Bay is very well seen from the water. No. 23 of our section is the bed which appears to droop most. The angle of declension is not more than 2° : upwards of 20° feet ?

The remaining beds of the lower freshwater series are not seen where they rise from the shore in consequence of the debris, which has fallen and covered them up at their origin and through the greater part of their course. Beyond Alum Point several of the lower beds are seen *in situ*, but they are best exposed in the sand-pit at present worked. The following section gives an accurate measurement of the 26 feet of sands and marls that repose upon the pure white sand. The angle of inclination is about 1° .

	ft.	in.
32. Light gray sand with few freshwater shells	2	4
33. Compact gray marl full of compressed <i>Lymnæi</i> , &c....	0	9
34. { Greenish stiff clay	5	9
{ Seam of lignite, vegetable structure shown	0	3
35. { Greenish clay, very tough and tenacious	6	0
{ Seam of lignite, about	0	3
36. { Gray sand	2	4
{ Seam of lignite	0	5
37. Yellow clay, ochre-coloured	4	9
38. Yellow sand	4	4

This forms the floor of the section.

39. Fine white sand. The uppermost bed is a very fine pure white sand dug for making glass, and is largely exported for that purpose. It has proved a California to the proprietor, as it is sold for about 14s. a ton. The white bed passes into one of a pale ochre colour, and then into another of a deeper tint striped with yellow bands. The thickness of the sands at Headon Hill is unknown, as the bed dips beneath the sea. The equivalent bed at White Cliff Bay measures 200 feet in thickness. No fossils have been found in this bed. I observed only fragments of shells, too minute and water-worn to ascertain to what genus they belonged.

Barton Clay Group.

No. 40. A great bed of brownish clay which consists of several subordinate beds. It forms "stratum B" of Webster's sec-

tion. It is traversed by seams of small flint pebbles and by six or seven layers of septaria. At the mouth of the ravine is a hard brown clay, the equivalent of the brown clay which rises near Beacon Bunny in the Hordle section. It contains the same shells, but they are at Alum Bay in the form of casts. I observed in one block, *Nucula*, *Venericardia*, *Oliva* and *Pleurotoma*. It contains much iron and three layers of septaria. The next portion is the true representative of the Barton clay. It is very fossiliferous, but the shells are much crushed and fragile. It is traversed by a layer of septaria and seams of small black pebbles; then follows a thick bed of green sand with few shells, which passes into a stiff brown clay containing vast quantities of *Nummularia elegans*. Then succeed beds of green sand with few shells, and six or seven layers of septaria. This bed measures about 300 feet.

In the following list I have given the Barton shells that are most abundant, but not all the genera and species contained therein :—

Ampullaria acuta.
 — *patula*,
Actæon simulatus.
Ancillaria canalifera.
Arca elegans.
Buccinum junceum.
 — *labiatum*.
 — *desertum*.
Cancellaria evulsa.
Calyptrea trochiformis.
Chama squamosa.
Conus dormitor.
 — *scrobiculus*.
Corbula pisum.
 — *globosa*.
 — *revoluta*.
Crassatella sulcata.
Fusus acuminatus.
 — *bulbiformis*.
 — *longævus*.
 — *errans*.
 — *minax*.
Lucina mitis.
Mitra scabra.
Murex asper.
Natica ambulacrum.

Nucula similis.
 — *minima*.
Nummulites lævigatus.
 — *elegans*.
Ostrea flabellum.
Oliva Branderi.
Pecten reconditus.
Pectunculus deletus.
Pleurotoma colon.
 — *comma*.
 — *prisca*.
Pyrula nexilis.
Rostellaria rimosa.
Sanguinolaria Hollowaysii.
Psammobia compressa.
Triton argutus.
Trochus monilifer.
Turritella imbricataria.
Typhis fistulosus.
 — *pungens*.
Venericardia globosa.
Voluta luctator.
 — *lima*.
 — *spinosa*.
 Teeth of *Squalus*.
 Teeth of *Myliobatis*.

In reviewing the facts disclosed by the study of the preceding section, the following consequences may be logically deduced therefrom :—

1st. That during the deposition of the series of beds comprised between the upper lacustrine and Barton groups, many alterna-

tions of physical conditions from river or lake to estuary and sea prevailed.

2nd. That the upper lacustrine strata exhibit such alternations, is shown by bed No. 2, but still more clearly by the section at Hampstead Cliff, which belongs to this group. The consideration of its beds does not fall within the limits of our section, belonging as they do to a higher zone in the upper lacustrine series. The lower lacustrine beds present similar phenomena.

3rd. That the estuary conditions more especially prevailed before and after the deposition of the intercalated marine bed.

4th. That the upper marine indicates a period in the struggle between sea and lake, when the former obtained for a time the supremacy: the marine shells and sharks' teeth it contains prove this condition.

5th. The white and yellow sands at Alum Bay immediately overlying the Barton group were probably of estuary origin. The absence of organic remains leaves a doubt upon the subject. The equivalent bed however at Beacon Cliff on the Hampshire coast, which I shall more particularly describe in a future communication, contains a large quantity of estuary shells mixed with true marine genera, together with the bones of turtles and the teeth of sharks. Guided by these facts, we infer that the white and yellow sands of Headon Hill were the great estuary deposit which introduced the lacustrine conditions under which the lower freshwater group, with the other intercalated estuary beds, were deposited.

*Address read to the Cotteswold Naturalists' Club, at their
Winter Meeting, held at Bristol, Feb. 10, 1852.*

By T. BARWICK LLOYD BAKER, Esq. of Hardwicke Court,
President.

AGAIN, Gentlemen, do we meet at the end of our summer—a summer, we trust, not unprofitably spent, whether as a Club or in our own separate avocations, and still do we find our Club flourishing, our papers increasing, and the interest felt by the members, as far as we can judge, growing more and more vivid.

Our Winter meeting of last year was at Cheltenham, where a party of twelve members and two friends sallied forth from the Lamb—after breakfast—to examine choice specimens of nature—not altered, but assisted and preserved by art—in the drawers of our friend and most valuable colleague, Dr. Wright, and amongst them the beautiful, and, at that time, undescribed species, of *Pteroceria*, which he has permitted our Club to have the honour of first making known to the geological world. We then received the kind permission of Mr. Fowler to examine his collection—less extensive, but most curious in the beauty and perfection of the specimens; and the Club then divided into a Geological and an Ornithological section, and separated—to meet at dinner.

The Geological section (to which we will give precedence by right of numbers) proceeded in an omnibus to the base of Leckhampton hill, and then walked up to the quarries, where Mr. Brodie called the attention of the Section to the "Bone Bed" at the base of the inferior oolite, and other strata well exhibited there; and on their way back they had the pleasure of meeting a brother Geologist, in the person of a professed dealer in "ancient fossils and antediluvian remains." What were the relative proportions of the specimens knocked out with a silver hammer at the bottom of the hill, and those discovered by an iron hammer at the top, is not accurately stated in the notes of the Secretary; but one recipe recorded therein merits publication, namely, a method of preserving delicate and fragile fossil shells from injury, by steeping them in one-eighth of an ounce of gum tragacanth dissolved in a pint of water. When dried after this saturation their consistency is greatly strengthened.

So far is recorded of the Geological Section of the Club.

The Ornithological Section, on the other hand, loftier in its aspirations though smaller in its number, required not an omnibus for its transport, but borne alone by the two legs of the President, proceeded to a large field on the Tewkesbury road, in company with two gentlemen Falconers, and an attendant bearing a noble Falcon and a cast of Tercels, hooded and belled. I had much conversation on the way with the chief of the party, and whatever else may be said of him, he certainly possessed much curious information relative to the races of falcons used in sport, whether those races be, as some hold, distinct species; or, as others may

rather incline to think, permanent or nearly permanent varieties. It is a curious fact, by the way, and one much to be regretted, that Falconers and Naturalists never appear to consult each other. It was a fact long known to all Falconers that there were two species of Gyr Falcon, while all naturalists declared that there was only one species; till, at the Newcastle meeting of the British Association, in 1838, Mr. Hancock, of Newcastle, (whose "Gorged Falcon," in the Crystal Palace this year, shewed him to unite the qualities of a Falconer and a Naturalist in a rare degree) produced a set of specimens both of the Norway and of the Iceland Falcons, which cleared up the point, and convinced the Naturalists that the Falconers were right.

I am greatly inclined to think that there is yet much of the history of this interesting group of birds to be gained from the Falconers, if we could see them; but, alas, that race itself has so dwindled away, that this day was the first on which I had even had an opportunity of seeing an hawk flown, and nearly the first conversation I had ever had with a *student* of the science.

I was aware, of course, that the stately heron was not our destined quarry, but confess I regretted that a pigeon was to be thrown to them instead of finding a partridge at the least. I soon found however my mistake, as the flight at a pigeon is infinitely more interesting than that at a partridge.

The Tercels were thrown off, and when well on wing the pigeon was thrown to them. Had the hawks been in perfect condition and regular practice, I believe they would have taken him nearly with certainty, but as it was, they chased him, striking at him and turning him for a considerable time, till he reached some trees a quarter of a mile off or thereabouts, when they returned without him: but a second pigeon, not flying quite so strongly as the first, was taken after a very short flight.

The flight at a partridge is tame work by comparison, as when the hawk gets his proper elevation, a single pounce generally secures the steady and straight flying bird; but to see a tercel first gain his elevation above the pigeon, and then make his stroke, (a beautiful thing in itself,) and then to see the pigeon, by the most violent exertions of his powerful wings, doubling, flinging himself head over heels, as it were, in the air to avoid the stroke, and still to keep making his way towards the cover, was a sport somewhat indeed like coursing, but as superior to it in beauty and interest as the locale of the one is physically to that of the other.

Another friend, who has much experience in falconry, has given me an account of one tercel, trained by his brother, who during his first year never missed killing a pigeon single handed; and that on one occasion, when a pigeon passed over a plantation, he was seen to take his place below his quarry till the plantation was passed.

One other scene, however, was enacted ere we left the field, which I would not have missed on any account, though it was one which certainly should never have been exhibited under the name

of sport, and least of all to a large number of ladies. The Falcon had just moulted, and had not recovered her plumage or strength; and it is necessary, under such circumstances, to allow them to kill a large bird occasionally to restore their habits and courage. A common chicken generally serves for this purpose, and of course, were it but for the ridicule of the thing, it is usually done strictly in private. The chief of the party, however,—whom we name not (by any name,)—determined on this occasion to have this feat performed in public, and, as might be expected, some laughed immoderately and some were greatly disgusted. I myself could have joined either party, had I not been so extremely interested in observing the instinct and habits of the bird under unwonted, and, as she seemed to think, most unpleasant circumstances.

On being hooded off she circled in short rapid flights round the Falconer's head, waiting on, as it is termed, while he walked some hundred yards into the field; and it was worth going some distance even to see that flight.

The poor chicken was then thrown down, but the falcon, though hungry, had no notion how to attack an animal on the ground. She stooped, indeed, once or twice, but seemed unable to bring her ideas to so low a level, and passed over the fowl's back. She then continued waiting on for a time, in hopes of nobler game, and finding none made another stoop or two at the chicken with equally bad success. She then tried another plan;—with the chivalrous spirit of a knight of old, who having unhorsed his enemy, would waive the advantage, and dismount to renew the combat on foot, the Falcon descended to earth, and quietly walked up to the hen. But, as a knight, in a stiff suit of tilting armour, would find it no easy thing to move himself or use his spear when off his horse, against an active boy in a smock frock, so was the Falcon equally at a loss. The hen ran away, and the Falcon stood still and looked. Meanwhile the poor hen recognized even from a distance her natural protector, man, and in spite of the Falconer's efforts, she kept running towards the crowd of spectators on the road, and had made two thirds of the distance, when the Falcon, savage at being foiled, although angry with herself apparently at having to perform so low a part, after several ineffectual clutches, which only knocked off some feathers, at last stooped her pride so low as fairly to seize the poor chicken, and of course all was over immediately.

On our return to Cheltenham, I was shown a really beautiful collection of Falcons and Hawks used in the sport, all stuffed by Hancock, and I never saw displayed so perfect a knowledge of the attitudes and habits of that race, till I saw those, by the same hand, in the Great Exhibition of this year.

But here, gentlemen, suffer me to make a long interpolation; for the friend, to whom I before alluded, has kindly given me the following sketch of the Hawking Club at the Loo, and allowed me to present it to the Club.

"The last Hawking establishment in England, which was conducted on a very liberal scale, and which had for its object the pursuit of the lordly Heron, was kept by a small society of gentlemen who had their annual meetings at Didlington, the seat of Lord Berners, in Norfolk. Twelve or fifteen years ago (when, from various reasons, the Club ceased to exist) some of the members unwilling to be deprived of their favourite sport, determined to look out for a new arena.

"In some old history of the middle ages, it was found that the most celebrated ground for Falconry had been at the Loo, in Holland, in the neighbourhood of Arnheim. Thither some of our amateur sportsmen bent their way, and found that every requisite for carrying on the sport on a princely scale still existed. The Palace at the Loo was once the favourite residence of our Great William.* It was here that his noble mind relaxed itself from the turmoils of war and politics, and enjoyed in quiet the chase of the red deer, which are not yet extinct in the extensive woods which surround Het Loo.

"This palace was now the seat of King William the First, who having resigned the Government of Holland to his son, had chosen that delightful spot for his residence. To him then was application made for permission to form a Hawking Club at the Loo. The proposal met with the greatest encouragement from him; and his grandson, Prince Alexander, was named President of the Club; of which the present King of Holland, and most of the Dutch nobility, with about a dozen Englishmen, were members.

"The grounds at Het Loo are as favourable as is possible for the sport. An immense Heronry is situated in a lofty wood, and the country around consists of dry sandy plains. The season for the sport is in May, June, and July, while the Herons are engaged in rearing their young.

"The site of the day's sport cannot be fixed till the morning arrives. It must be to leeward of the Heronry, as that bird always turns down wind when pursued, and could he reach the high wood in that direction, it would not only soon terminate the sport and protect the game, but very probably cause the loss of the Falcons.

"The Falconers employed by the Club, of whom there are two distinct parties, of three or four men each, reside during the greatest part of the year at their native village of Falkensvaerd, where their forefathers have followed the same profession and supplied Europe with Falconers from time immemorial. On the plains near their home, the young Falcons, Peregrines, who have already learnt to prey for themselves, are caught in the autumn or winter, by means of a pigeon and a bow net, and put in training for the spring campaign.

* NOTE BY THE EDITOR.—Some doubt having arisen as to who my friend means by our Great William, I am requested to explain, that it does not allude to a highly respected member of our Club who might merit that title, but to William III., whom Waterton irreverently designates "Dutch William."

"They are first taught to pursue pigeons; and when quite reclaimed and perfect in that flight, they are broken from pigeons and entered by degrees to the Heron. In its wild state the Peregrine does not attack so large a bird as the Heron: many unfortunate hens have to be sacrificed before the Falcons acquire the courage that is necessary for that flight.

"The number of trained hawks brought by these Falconers to the Loo every spring is generally between forty and fifty; few, and only the best of them, are kept through the moulting season, and a new supply of young birds is procured for the following year. The birds of the first season are considered faster and better than older birds.

"Besides the professional falconers, Mr. Newcome, of Hockwold, a Norfolk gentleman, frequently brings some Falcons with him to the meeting. He is, perhaps, the first practical Falconer in Europe, and the condition, and consequent high courage of his hawks has frequently exceeded that of the professionals.

"On a hawking morning, the two sets of Falconers proceed to the appointed ground, taking with them, on frames made for the purpose, as many cast of Falcons as they consider fit to be flown on that day. The company follow, and take their station generally on some low range of hills, crossing the plain, and wait the appearance of a heron. Two pair of mounted Falconers, each with a Falcon on his fist, in full costume of hood and bells, take their stations a little in advance of the company, forming a kind of line with them, and about a quarter of a mile distant on either hand, another mounted Falconer, but without a hawk, called the down wind rider, takes his station from half a mile to a mile down wind of the line, the distance depending on the strength of the wind.

"At length the cry of '*à-la vole*,' (the tally-ho of hawking) announces that a Heron is in sight, bringing slowly home the produce of the morning's fishing to his nest. The two Falconers, at that end of the line nearest to the Heron, now see him, and, bending down on their horses, take advantage of every inequality of the ground to get as near as possible to the point over which the Heron will pass. He is allowed to pass the line in fancied security, and proceed a little way up wind towards his home.

"The hawks are then hooded off, the flight commences, and the horsemen start in pursuit. The moment the Heron perceives that he is followed, he proceeds to disgorge the fish he has in his crop, which falls heavily to the ground. He then turns his head down wind, and mounts as fast as he can, his object is to prevent the hawks from getting above him. It is curious to observe the different ways which some of the best and favourite hawks take to gain their vantage height. Some fix their eyes on the quarry, and work upwards in a straight line towards it. Others slip away on the wing, and rise to their pitch with a long gradual ascent, at a great distance, and quite in another direction from the Heron, and when they have reached a proper elevation, sweep like lightning round, and appear suddenly above the chase.

"But, see! Thunderbolt has reached her pitch, and soars high above the Heron—she stoops—she has missed him; the impetuosity, from which she gained her name, has brought her far below the Heron, and it will be long ere she gets above him again.

"Now, der Ruyter has taken her place. Ha! der Ruyter! good hawk. Der Ruyter has missed him. Again and again the Heron dodges his pursuers, and has risen by this time to an immense height. He has passed since he turned down wind, over a space of nearly two miles in a very short period, rising continually on the wind. At last he is struck; the other hawk closes rapidly to him, and all three come to the ground together. It is now that the use of the down wind rider is seen; the flight has been so rapid that the Falconers, who hooded off the birds, are still half a mile distant, and the down wind rider alone is at hand to take them up. In very long flights, when the heron escapes, he is of even more use, and without him the Falcons would frequently be lost. On such an occasion, he should be far a head of the other riders, when, taking a pigeon from his pouch, he swings it in the air as he gallops along, and shouting his Falconer's cry at the top of his voice, generally succeeds in taking up the hawks. Towards the end of the season, when the Falconers are not so much afraid of loosing their hawks, they fly the light Herons that are leaving their nests, in preference to those that are coming home so heavily laden. These show very long flights, and sometimes a gallop of three miles at top speed will fail to bring the rider to the end. The first amateur who is up is entitled to the Heron's plume, and after a long and rapid flight there is much rivalry as to who shall have the honour of carrying back that trophy to the hill on which the ladies remain, and with their glasses frequently see as much or more of the flight than the hardest riders.

"On a perfectly still day the Heron will frequently mount into the air in a continued spiral circle, like a cork screw, and the sportsmen leaning back on their horses, without moving a step, watch the three birds mount into the clear blue sky, to a height at which the human eye can hardly distinguish them.

"The Falcon generally used for this sport is the female Peregrine; Jer Falcons have been procured from Norway, and Iceland Falcons from that island, and flown at Het Loo. These kinds are larger and faster than the Peregrines, but either from their being of a more sluggish disposition, or from their nature and requirements not being so well understood by the Falconers, the best sport has been usually shown by the Peregrine. In fact, a cast of bold and well trained Peregrines is fully a match for a Heron.

"The rook will often show a good flight when pursued by a bad falcon or tercel, and a flight of this sort is a pastime that frequently enlivens the ride to cover, or the return home; but the rook is a shuffling, cowardly bird, and endeavours to escape by hiding himself and taking advantage of all sorts of mean subterfuges, instead of depending nobly on his own powers and facing the clear and boundless sky like the Heron.

"The zest with which the Princes of the house of Orange enter into this noble sport can only be exceeded by the princely affability with which they welcome the members of the society; showing that even a crown shines with additional lustre when worn by the first gentleman, as well as the most powerful prince of his people."

Allow me, Gentlemen, to congratulate you on the possession of so graphic an account of a pastime, of which, in the present day, so little is really known, but which has always been a matter of equal interest to the sportsman, the naturalist, and the antiquarian.

But from hawking we must "return to our mutton," as we did—at the Lamb. After which, Dr. Wright gave us his description of his new and extremely beautiful species of *Pterocercis*.

The President gave a rough sketch of the proceedings of the Club during the summer; and the Secretary made the hitherto unheard of demand, for the sum of 3*s.* 6*d.* from each member for the year's expences, and after fixing the days of meeting for the following summer, we adjourned till our first spring meeting on May 13.

On this day our Club assembled in large numbers at the White Hart Inn, at Cirencester, from whence we visited—first, the house of our Archæological, as well as every other o-logical member, Mr. Buckman, who had kindly spread out for us on his floors, the original tracings of the tessellated pavements lately found at Cirencester. These drawings being not a copy merely of the general outline and colouring, but actual tracings of every tessella coloured on the spot, represented the original works of the Romans with a fidelity which will not be surpassed—till Lord Bathurst shall have carried out the design which he has undertaken with the spirit and liberality which characterizes all his works, whether for the good of the town of Cirencester, or for the benefit of the neighbourhood in general, of erecting a building in which these choice and interesting relics of ancient times shall be deposited, and secured to future ages, free from the risks that must attend their present literally transition state. There is no lover of archæological research, no well wisher to the town of Cirencester, who does not look forwards anxiously to seeing these pavements secured to posterity—by design (as they have been secured to our time by obscurity) and to the adding to the town an attraction which can be equalled by nothing—except Mr. Villebois' hounds.

We then proceeded to the College, where the Museum of Natural History has been arranged with a care which, we trust, will encourage all who can assist it, to do their best to add to a collection, which has shewn itself really worthy of the best help which can be given it, especially—as regards the immediate objects of the College—the room attached for preparations illustrative of veterinary science, under the able direction of the Professor of that branch of agricultural instruction, Mr. Brown. We then walked through the farm buildings to the railroad cutting through the Bradford clay—at the point where it crosses the Ackman street—where we found even in our brief search, many specimens of its

fossils, such as the *terebratula decussata*, *orbicularis*, *digona*, &c., and where Mr. Buckman and the students of the College, have collected no less than 223 distinct species of fossil remains.

We then proceeded along the railroad to a little beyond the Kemble station, where a curiously distinct fault was shewn in the cutting before passing the tunnel, where the Cornbrash, the Forest marble, and the Bradford clay, have sunk so low, that the Cornbrash on one side of the fault is brought down to a level with the great oolite on the other.

We then returned by the banks of the Canal—looking into the remains of the Amphitheatre by the way—to our dinner at the White Hart. But here occurred a difficulty which I much regret to record, and which I propose to make a ground of a special motion for the consideration of the Club. Although we utterly and with scorn deny the imputation which some of our calumniators venture to assert—namely, that the dinner and that ethereal dew of the mountains which usually succeeds it, forms a principal attraction to our meetings—though we have striven most successfully throughout our existence to retain that absence of luxury—that almost eremitical fare which would prevent such assertions from those who knew aught of our habits—yet there can be no doubt that it behoves us, more especially as students of nature, to remember that nature ought to be supported.

Now, our excellent Secretary has taken care—on all the cards, on which he sends us the notices of our meetings, to print most legibly “An answer will oblige.” Alas for the frailty of even Cotteswoldian man! Will it be believed that there are any who are not anxious to oblige the Secretary? Yet so it is. Now mark the consequence. The Secretary being led to expect about twelve to dinner, made his preparations for that number. For twelve did mine Host of the White Hart provide a sufficient repast. But when nearly *thirty* appeared to partake of it—whose fault, I ask, was it that the table proved all too small? and though, thanks to our being in the good town of Cirencester, mine Host was enabled both to get other tables and to eke out a bare sufficiency to place thereon, yet had the same case occurred at one of the more usual habitats of the Club—some small hostelry in some lone and sequestered valley of the Cotteswoldes—I tremble to think of the consequences. I even find the following observation recorded in the notes: “Though unexpected pleasures are often agreeable—the Secretary finds that he derives even greater gratification from dwelling some days previously on the thoughts of meeting such and such friends, than from the sudden apparition of an unlooked for (though not unwished for) member—followed mayhap by several friends (all extremely agreeable—*but*) for whom no provision has been made in the bill of fare.

Now the motion which I beg to found on this appalling statement is as follows:—

That our Secretary do prepare a list—to be laid before the Club this day six months—or some other time—of all who on this occa-

sion failed to comply with his very reasonable request, and that the club do consider in the meantime, whether the offenders shall be deemed guilty of high treason to our King of Clubs; and (we will omit two of the penalties—but) be quartered elsewhere; or, whether they should be subjected to club law and fusticular punishment; or, whether they should be debarred their allowance of whiskey for the future—unless indeed they compound for their transgression, by bringing a bottle of the pure nectar of the mountains to a subsequent meeting.”

Gentlemen, I leave this important subject to your consideration.

After dinner at various tables, we crowded together at one board, where, the minutes of the former meeting having been read—Mr. Pooley exhibited the foot print of a Saurian reptile, found in the Stonesfield slate, at Farmington, near Northleach; together with a photograph or calotype which represented it admirably. A letter was also read from Professor Owen, who promises to examine the specimen more fully, and describe it in a forthcoming work. This valuable specimen belongs to Robert Brown, Esq., of Barton Bury, near Cirencester.

Mr. Buckman then described and exhibited, a very curious variety of the *Lamium album*, or white dead nettle—the peculiarity of which was—that the lateral teeth in its flowers were all changed or developed into side lobes. This is interesting as shewing that these teeth, which have been made a generic character by botanists, ought not to be so considered, being only undeveloped lobes, like those we see in many other genera of the labiate flowers. Mr. Buckman states that he has, for some years, watched the plants from which these flowers were taken, and that they always produce flowers of the same kind. Dried specimens also of that rare plant—the *Thlaspi perfoliatum*—were distributed to many of the members by Mr. Buckman; one of whose pupils had found it growing near Sapperton. Its great interest, in addition to its rarity being, that it has never been found on any other formation than that of the great oolite.

Dr. Wright then gave us a theory of the oolite marl, which occurs above the freestone beds of the inferior oolite, which he designated as a coral reef. This led to an animated discussion between Professor Buckman and himself, and I find it on record that the President observed, that as when thieves fall out, honest men came by their rights; so, when men of high talent dispute a point, the ignorant at least may pick up many scraps of information; and few are better able to judge of the feelings of this latter class than the President.

On the 24th of June, absence from the County prevented my attendance at the meeting of the Club. I must, therefore, give you the animated account of the proceedings kindly afforded by the notes of the Secretary.

“Our excursion was to be directed towards the quarries near Sevenhampton, where the Stonesfield slate has been worked. On reaching the hill above Seaford, in sight of Mr. Beale Browne’s

steam engine chimney which crowns the opposite rise, we turned up the hill to the left. The road hitherto had led through a pretty and undulating grass country with woods, on gravel and lias clay. We soon found ourselves on arable land with stone walls; the inferior oolite being exposed in a quarry which we passed. From this rise a fine view is presented looking back to Leckhampton and Church Down Hills. The thickness of the great oolite is here but small, as we soon found ourselves at the quarries where the Stonesfield slate, its highest member, is exposed—having above it a clay, said to represent the Bradford clay. We searched in vain, however, for one of the characteristic shells of that formation—the *terebratula digona*. The *ostrea acuminata* is the most prevalent; which is found all through the Stonesfield slate.

Some specimens of the Bee Orchis were dug up to be transplanted to more civilized haunts; but Mr. Buckman suggested that one reason why the attempt so rarely succeeds is, that it is usually made while the plant is in flower. Mr. Buckman mentioned to us several rare plants which were found in this neighbourhood, such as the beautiful *astragalus hypoglottis*, found on the crest of the hill; the *A glycyphyllus*, found in the bushes; the *lathyrus sylvestris*, in the hedge by the path ascending Agg's hill; and above all, in Puckham Scrub, the *melittus melissophyllum*, "the glory of the Cotteswolds." To some people, be it observed, we might fear to publish this information; lest ruthless plunderers should attempt to perfect their own collections at the expence of the nature they profess to admire. But far be such thoughts from the members of our Club! Nay, we venture to make known among ourselves, the habitats of these rare plants, in the full conviction that each Cotteswoldian will not only be moderate in helping himself to no more than the locale can well spare, but will be careful to avoid communicating the intelligence to any who are not sufficiently honest and true to nature, to be trusted. Perhaps, indeed, we may be excused for suggesting, that the best way of avoiding the betrayal of nature's secrets to such persons, would be the carefully eschewing their company altogether.

On this occasion, however, the Club, it seems, did not even succeed in feasting their eyes on them; for having whetted their appetites most keenly among the oyster beds of the Stonesfield slate, they, by an unfortunate mistake, it appears, missed the road through Puckham Scrub, and took, instead, the direct road to Cheltenham, where in some degree—the dinner—but in a much greater degree the first part of Dr. Wright's interesting lecture on the echinoderms served to console the members for the loss of the *melittus melissophyllum*.

On August 5th, the Club commenced its third meeting at the hospitable board of our member Mr. W. Phelps, at Chestal, near Dursley; from whence—after examining some curious masses of recent calcareous tufa, containing leaves of plants, shells, &c., which were quarried at the bottom of the grounds, and, affording a lasting as well as picturesque weather stone, are built into many of the walls,—we crossed the valley and ascended the opposite hill

through the woods of Mr. Bengough, of the Ridge; and thence through those of your unworthy President, and those of Mr. Stoughton, the Club completed the circuit of the valley of Uley, (of which Dursley is the gorge), and returned by the way of Uley Bury and Downham to Dursley. Mr. Buckman promised the Secretary a list of the numerous botanical species collected in the day's research. But, alas, I am afraid that it remains with the paper on the mistletoe bough—and some others long promised us—and if a report which has just reached me be correct, we must not now assume the tremendous severity with which we should have called on him to shew the reason why, but must leave his reformation in other hands, wishing those hands every possible success in their undertaking.

I must, however, allude to a piece of small pride of my own. In one small hollow, which appears to be a continuation of the hollow-way, leading from the northern entrance of the intrenchment on Uley Bury, close to the point where the road up Lampern Hill enters the wood, a friend of mine, two or three years ago, drew my attention to a natural fernery of great variety, and in frequent visits I have found in the space of about 100 yards by 40, the following species of ferns, all growing with unusual luxuriance:—

Polypodium vulgare	Asplenium trichomanes	Athyrium filix femina
P. dryopteris	Aspidium angulare	Scolopendrium vulgare
Pteris acquilina	Lastrea filix mas	
Blechnum boreale	L. dilatata	

The *Ceterach officinarum* and the *Asplenium ruta muraria* abound about two miles off; the *Polypodium Calcareum* is in the woods near Woodchester; the *Aspidium Aculeatum* abounds in all the woods of the valley though not in that particular spot.

There are few grander points of the Cotteswolds than the Roman* entrenchment on Uley Bury; whether, in our walk round the embankments, we look up the Vale to the Malvern Hills, or across it to the Sugarloaf and other Welsh mountains, towering over the Forest Hills, with the wide reach of the Severn called Frampton Bay, and the broad and rich Vale at our feet; or, to the left again, down the Vale to the waters of the Bristol Channel with Stinchcombe, Peak Down, Cam-down, and Downham Hills on the left; or, finally, turning south-east, look back into the lovely valley we have spent the day in compassing, with its deep beech woods surrounding the fine timber and luxuriant verdure of its meadows;—to say nothing of the interest, archæologically speaking, of the entrenchment itself, with its three perfect entrances and the two covered ways leading from each. All make Uley Bury a point of unusual interest.

After dinner, at the Old Bell at Dursley, as there was no paper to be read, Mr. Buckman, who has a wonderful facility in coming to the rescue where he is *extremely* wanted (though were he to present himself whenever he is wished for, he must divide himself

* Originally British, as shewn by its irregular form—but altered and perfected by the Romans.

into as many parts as he has friends),* called the attention of the Club to some new works on Natural History. Firstly—deservedly firstly,—to a “Manual of the Mollusca,” well worthy the attention of every naturalist, not only because its author is S. P. Woodward, whose name is something in itself—nor only because he is an associate of the Linnean Society, and an Assistant in Geology of the British Museum; he has a far higher claim on our attention, in being “a member of the Cotteswold Naturalists’ Club.” I confess I no sooner heard the fact than I immediately purchased two copies, determined to read them *both*. Mr. Buckman then alluded to the second edition of one of the most pleasing guides to the wild flowers of England and Wales, “The Botanical Looker-out,” by Edwin Lees, F.L.S., the President of the Worcester Naturalists’ Club, a sister institution of our own. The Secretary’s account concludes with mentioning Mr. Buckman’s *promises* to bring to Bredon some notes on the *Yucca Gloriosa*. *Which he didn’t*. However, we’ll say no more of that at present.

On September 16, *the Club* met, nominally, at Bredon. Why it was, I know not—the distance does not appear greater for the majority of the Club than Dursley—but somehow there appears to be a fate against our meeting there. We have tried it before. On the former occasion, though our highly-valued member (I might say in his long absence from us, our regretted member) Mr. Strickland, offered us not only breakfast, but the sight of his Collection into the bargain. A Collection—not of a *Collector*, but of a *Naturalist*—not a number of ill-arranged objects, each valuable individually from their rarity, but leading the mind to nothing beyond; but a collection made subservient to illustrating grand views of the course of nature, which must lead the mind to something far beyond the petty pleasure of merely possessing that which your neighbour has not. If even the hope of studying Mr. Strickland’s collection failed to attract the members of the Club, how could we wonder that at our second attempt at meeting at Bredon, a *partie quarreè* of the President, the Secretary, Dr. Wright, and Mr. Jones, formed the whole representation of the Club. However, a small meeting may occasionally see somewhat, and may suggest ideas to those who do not choose to attend. *Imprimis*, a point by no means alien to Natural History, we found in the Royal Oak, at Bredon, a grate, which diffused caloric in a most unusual degree, in proportion to its size. The grate consisted merely of three bars and a bottom, built into the brickwork on each side. The sides were two simple perpendicular planes of brick, meeting at an angle of 108°, or thereabouts, at the back. If this be found, as I believe, to radiate heat in an unusual degree, I beg that it may be carefully kept secret from all those who would not come to Bredon on that day.

After breakfast our very small party, in the way to Bredon Hill,

* He is doubtless an odd fish—perhaps he might—like the polypus—bear division. Not that I will be the one to cut him.

examined some pits, where a gravel is worked to some ten feet in depth, composed of rolled pebbles exactly like a sea beach, consisting of quartz, variegated sandstone, silurian sandstone, traps, and some chalk flints. The workmen talked of shells, but on examination the shells proved to be gryphae from the clay below.

I must now, however, give the Secretary's account in his own words. "Our way up the hill led us by some remarkable masses of rock, called the King and Queen; others were seen of a similar nature afterwards, one very large one near the Summer House, as a tower on the summit is facetiously called. We came to the conclusion that they belonged to the ferruginous beds (pea grit), near the base of the inferior oolite. They resembled angular blocks of stone united together by a calcareous cement, and might almost pass for the remains of a very thick ancient wall. We afterwards reached a quarry of great depth, the rock being singularly fractured and fissured from top to bottom. Looking at the extensive plateau of uneven land (thrown up into hillocks, and scooped out into hollows, which resembled a succession of old quarries, but is far too extensive to have been so caused), upon which these fractured rocks rest, the Secretary was led into theorizing on the subject, and it may give rise to some enquiry and discussion on the matter if he ventures to communicate his ideas to the Club. May it not be possible that the clay of the lias shale, which underlies the lower beds of the oolite, has been washed out by the water percolating through the porous oolite, and has thus caused hollows, which, when they reach a certain size, cause a fall of the strata above and a disruption of the rocks, such as we see occur in coal mines where the mineral has been taken out? There are issues of mud along the face of Bredon Hill, whence occasionally a sort of flowing bog bursts forth, and covers some of the land below with clay. The stratum of rock being thus broken up, the harder and larger masses, like the King and Queen, might easily be supposed to stand *in situ*, while the surrounding softer parts were gradually washed away. However this may be, the shaly beds of the lias clay are well seen at the bottom of the oolite escarpment; and beyond them the marlstone, forming an uneven line, and another steep escarpment which is usually clothed with a belt of wood."

Should this opinion of our Secretary's be disputed, I cannot but hope that it may lead to a discussion like that at Cirencester, in which even men as ignorant as your President may pick up some useful information.

In our way down, we spent some time at a quarry of the marlstone, full of fossils: a vertebra of an Ichthyosaurus, a fish tooth, numerous belemnites, and a page full of other species being collected.

We then asked hospitality, where hospitality was never wanting, at Woolashill, the interesting and beautiful seat of Mr. Hanford, and returned to Bredon, where Dr. Wright, notwithstanding the small size of the party, read us the conclusion of his interesting

paper on the echinoderms, illustrated by a number of beautiful specimens, observing most justly, that whatever members are present constitute a meeting, and that it would be a bad precedent to give or withhold papers, according to the numbers present. This paper was indeed worthy of a far larger audience, and the Club may boast of a contribution to science, of which large and metropolitan bodies envy us the possession.

And here let me finish the account of the year's proceedings. I trust that I may congratulate the Club on its prosperity—for our prosperity does not mean wealth, rank, or honours—it means the enjoyment of healthy exercise in beautiful scenery—the cheerful converse and companionship of many friends interested in the same subject—and, above all, the raising of our minds to those thoughts which are equally excited by the relics of remote antiquity, found in the depths of earth, or by the powerful and rapid motions of the falcon in the air—by the insect, barely to be discerned by the microscope of man's utmost ingenuity—or by the mountain, whose vastness strikes us with awe:—even the more powerfully we feel the sense of our own nothingness, (which strikes us more strongly the more light we gain) by so much more do we estimate that light which leads us upward to nobler and wiser thoughts.

Contributions to the Palæontology of Gloucestershire:—On the Strombidæ of the Oolites. By THOMAS WRIGHT, M.D. *With the description of a new and remarkable Pteroceras.* By JOHN LYCETT, Esq.

READ 28TH JANUARY 1851.

AMONG the remarkable new forms of extinct gasteropodous mollusca which have from time to time been brought under the notice of the Members of this Society, there are none more interesting or more valuable as contributions to the oolitic fauna, than the winged shells belonging to the genera *Pteroceras* and *Rostellaria*.

The *Strombidæ* were first recognised as a distinct group of gasteropods by Lamarck, in which this learned zoologist assembled several forms having affinities with each other in the singular development of the outer lip of the shell; with these he formed his family *des Ailées*, which includes the genus *Strombus* of Linnaeus, and corresponds with the *Strombidæ* of modern naturalists.

This family is well characterized by the form of the shell and that of the animal. The shell in the young state is conical or spindle-shaped; after having grown in a regular manner for a longer or shorter period of time, its farther development is arrested, the outer lip becomes dilated, thickened and enlarged in a very remarkable manner, and sends out often long digitations; the anterior part of the mouth terminates in a canal accompanied with a more or less distinct sinus. The animal has the foot divided into two parts, the one posterior cylindrical and obliquely truncated and supporting a horny operculum. The other part is flat, rounded before, and adapted for attaching the mollusk to solid bodies. The head is large and thick, and is prolonged into a bifurcate extensible proboscis; the tentacula are large and divergent, and carry the eyes at their extremities. In this family are grouped the genera *Strombus*, *Pteroceras*, *Rostellaria*, *Aporrhais*, *Chenopus*, and *Pterodonta*.

The *Strombidæ* are first recognised in a fossil state in the different stages of the oolitic rocks. They are more numerous in the cretaceous and tertiary strata, and have attained their greatest development in the present creation. They are nearly all natives of tropical seas, and are most abundant in the neighbourhood of coral islands.

Pteroceras, *Rostellaria* and *Chenopus* are the most ancient genera of this family; they are still represented by numerous species all different from those found in a fossil state. A few species of *Strombus* have been found in the chalk; more have been met with in the different stages of the tertiary period; but this genus has attained its full development in the seas of the warm regions of our time, where the species are remarkable for their gigantic size, singular forms, and rich and varied colouring. *Pterodonta* has been found only in the chalk. Soon after Lamarck had formed the new genera of his family *des Ailées*, De Montfort* proposed his genus *Hippocrena* for the species included by Lamarck in the genus *Rostellaria* which had the labrum simple and dilated, the columella callous and forming a channel conjointly with the labrum, which ascends close to the volutions of the spire almost to its apex, the external lip with a simple straight wing inflected towards the base, and with a short pointed canal. He cited *Rostellaria macroptera* from the Barton clay as the type of his new genus, which however has not been adopted.

Philippi† recognised anatomical differences between the animal of *Rostellaria curvirostris* and that known as *R. pes-pellicani*; the latter has the eyes situated sessile on the sides of the tentacula, while in the former they are terminal and retractile; these with other zootomical characters induced him to propose the genus *Chenopus* for *R. pes-pellicani* and other allied species: it is just to observe, however, that Aldrovandus in 1623 described this typical species under the generic name *Aporrhais*, which is now adopted by British naturalists.

The living forms of *Chenopus* have the respiratory canal depressed and slightly channelled, and the labrum strongly digitated, whilst in *Rostellaria* the respiratory canal is much grooved and arched backwards, and the digitations when present are for the most part long, slender and flexuous. Many fossil shells from the oolitic and cretaceous rocks appear to occupy a position intermediate between these genera, and ought probably to be separated into a distinct genus; this in fact was suggested, and the genus *Rostrotrema* proposed, by Mr. Lycett, in a paper which he read before our Society in August 1848, for the reasons that the winged shells of the Oolite called *Rostellaria* differ from that genus in "the absence of the upper or posterior siphon upon the spire, the outer lip not extending beyond the body-whorl, or but slightly upon the penultimate, and there being no corresponding thickening upon the inner lip to form a channel."

* Conchyliologie Systématique, tome ii. p. 523.

† Enumer. Molluscarum Siciliæ.

Our esteemed associate informs me that he has now cancelled his former name and substituted *Alaria* for the reception of many of the winged shells of the Great Oolite hitherto described as *Rostellaria*.

The winged shells discovered in the oolitic strata of Europe belong to the genera *Pteroceras*, *Rostellaria*, *Chenopus*, and it may not therefore be uninteresting to make a few remarks on the fossil species of these genera. Goldfuss† and Münster figured and described two species of *Pteroceras*, *P. oceani* and *P. conica*, from the Kimmeridge and Portland stages of Germany, and five species of *Rostellaria*, *R. gracilis*, *R. subpunctata*, *R. semicarinata*, *R. tenuistria*, and *R. nodosa*, from the lias, and two species, *R. bicarinata* and *R. spinosa*, from the inferior oolite near Pappenheim.

Roemer‡ figured and described two species of *Rostellaria*, *R. costata* and *R. caudata*, from the coral rag of Hanover.

Koch and Dunker§ described and figured one species of *Chenopus*, *C. Philippi*, from the inferior oolite, and two species, *C. cingulatus* and *C. strombiformis*, with *Rostellaria nodifera*, from the middle oolites of North Germany.

Prof. Deslongchamps|| figured and described ten species from the oolitic rocks of Calvados in Normandy, five of which, *P. vespertilio*, *P. ponti*, *P. sexcostata*, *P. musca*, and *P. incerta*, are from the Kimmeridge clay of Honfleur, and five, *P. antractoides**, *P. vespa*, *P. balanus*, *P. retusa*, and *P. paradoxa**, were obtained from the great oolite of Ranville. This profound and accurate observer found five species of *Rostellaria* in the lias and oolites of the same region. *R. trifida** ranges from the upper lias to the Kimmeridge clay; *R. hamus** is common to the inferior and the great oolite; *R. myurus* is found in the inferior, and *R. hamulus** and *R. cirrus** in the great oolite of Ranville.

Prof. John Phillips¶ figured *Rostellaria composita*, *R. bispinosa* and *R. trifida** from the oolitic rocks of Yorkshire.

Mr. John Lycett described in a paper read before the Members of this Society and now published††, five species of *Rostellaria* from the inferior oolites of Gloucestershire, which he named *R. unicornis*, *R. simplex*, *R. spinigera*, *R. solida*, and *R. gracilis*, to which may be added three undescribed species from the shelly freestone and oolite marl of Leckhampton.

Messrs. Morris and Lycett will figure and describe twelve spe-

† Petrefact. Germaniæ, tab. 169 and 170.

‡ Versteinerungen des Oolithen-Gebirges.

§ Versteinerungen des Nord-deutschen Oolith-gebildes.

|| Mémoires de la Société Linnéenne de Normandie.

¶ Geology of Yorkshire, Part 1.

†† Page 62 of these Proceedings.

cies of *Rostellaria* (*Alaria*), and two species of *Pteroceras*, from the great oolite of Minchinhampton, in their forthcoming monograph* on the fossil shells of that locality, some of which are identical with Deslongchamps' species from Normandy. Those species which have been identified in the oolitic fauna of Gloucestershire are marked with an asterisk.

The *Pteroceras* which I have now the pleasure of exhibiting was discovered in the Great Oolite of Minchinhampton; it is by far the largest and most remarkable form of that genus which has been obtained from the oolitic strata of any country; its finely preserved spider-like digitations give the shell a most singular appearance. I am indebted to my friend Mr. T. A. Young of Dublin for the accurate drawing of the shell which accompanies this paper.

The following description is by my friend Mr. Lycett, whose extensive knowledge of fossil conchology well enables him to point out the affinities of this new species.

PTEROCERAS.

Gen. Char. Shell oval-oblong, ventricose; aperture oval, terminating in a lengthened canal at both extremities, the anterior in general bent outwards, the posterior taking the course of the spire; right border in the adult thickened and developed into a wing-shaped expansion, producing long digitate processes; an anterior sinus with a toothed border distinct from the canal; spire short, with the first digitation attached to it.

Pteroceras Wrightii. Plate III.

Shell fusiform, tumid; volutions (six) convex and smooth, the last volution inflated, having three obtuse gibbosities placed opposite to the aperture, of which the first is the largest; the outer lip is expanded and divided into four branches or digitations, which in the adult state are very long, flexuose, and nearly of equal size; the first digitation is attached to the spire; it extends more than an inch beyond the apex, where it is broken off; the second curves outwards and slightly backwards; the third is broken off near to the wing, but a remaining fragment shows that it curved outwards and forwards; the fourth first proceeds forwards and then suddenly curves outwards; the canal is long and curved backwards.

This fine species of *Pteroceras* appears to be nearly alone; one specimen in the cabinet of the author, without any labial expansion and otherwise imperfect about the last volution, is the only other

* Palæontographical Society.

known example. *P. Wrightii* in its perfect state would seem to have had five encircling striæ ; these are partially visible upon the inferior surface of our specimen, the coarseness of the oolitic deposit in which they occur being unfavourable to the preservation of any delicate sculpture. The surface of the body-whorl near to the labial expansion is much covered up by adherent oysters, but it appears to have been destitute of any encircling carinæ.

The general figure has some resemblance to the *Pteroceras ponti* of D'Orbigny, but that species has upwards of six digitations and as many costæ upon the body-whorl. The cast figured by Goldfuss under the name of *Buccinum antiquorum* from the dolomitic oolite of Bavaria, may possibly belong to our species, or otherwise to an allied form of the same genus. The remarkable specimen here described is in the collection of Dr. Wright of Cheltenham, to whom it is respectfully dedicated.

Locality. Minchinhampton : common to the varied fossil fauna, to which it is an important addition.

A Stratigraphical Account of the Section of Hordwell, Beacon, and Barton Cliffs, on the coast of Hampshire. By THOMAS WRIGHT, M.D. &c.—March 1851.

DURING a short residence in the Isle of Wight last summer I made a minute examination of the section from Round Tower Point to Alum Bay, with a view to ascertain the conditions under which the upper and lower freshwater and upper and lower marine formations of the Hampshire basin* were deposited. The result of these investigations was published in a paper read to the Club September 17, 1850. For the purpose of instituting a comparison between the eocene beds of the Isle of Wight and their equivalents on the Hampshire coast, a palæontological analysis and measurement of the strata constituting the sections of Hordwell, Beacon, and Barton Cliffs, on the opposite shore of the Solent, was undertaken, and which form the subject of the present communication.

The following notes were made upon the spot, and corrected and enlarged after frequent inspection. Their chief value consists in showing the order of deposition of the different beds; the changing conditions under which they were deposited; the points at which the most important of them rise on the shore and pass out of the cliff; with a catalogue of the fossil contents of each.

I beg to acknowledge the valuable information derived from the Marchioness of Hastings, relative to the fine collection of fishes, reptiles, and mammals obtained from Hordle Cliff, and now in her ladyship's museum.

To Alex. Pytts Falconer, Esq., of Beacon Hordle, I am likewise indebted for much valuable information relative to the osiferous beds of this locality†.

The quantity of debris that has fallen and obscured the origin

* Mr. Joseph Cotton, of Freshwater, supplies on very moderate terms a complete series of the fossil shells from the tertiary strata of the Isle of Wight.

† In the measurement of the beds and in investigating their fossil contents I had the assistance of Henry Keeping of Milford, who has had much experience in exploring the Hampshire section for the purpose of collecting fossils for the Marchioness of Hastings. From Mr. Keeping may be obtained at a moderate price the fossil shells catalogued in this paper.

and course of many of the beds will account for the discrepancy which may be found between my notes and those of other observers, who have either previously, or who may hereafter, visit this beautiful section under more advantageous circumstances. I have given as complete a list of the fossils contained in each bed, as the limited time devoted to the subject would admit of, and feel well satisfied that additions may be made to these lists, especially if a microscopic investigation of the sands and marls was undertaken. The places where the most important beds rise on the shore, and where they make their final outcrop on the cliff, have been noted. This mode appears to be the most natural for studying coast sections which are gently inclined at a low angle like the strata of these cliffs; it has the advantage likewise of assisting future observers to identify the beds and to make further investigations into their contents.

It is now nearly a century since Brander directed the attention of naturalists to Hordle and Barton Cliffs, in his work entitled '*Fossilia Hantoniensia*,' dated 1766. The author's intention was merely to figure and, with the assistance of Dr. Solander, to describe the shells found in the Barton clay. The beauty and accuracy of his plates have not been surpassed, but his description of the strata is very meagre. "They (the shells) are found," he observes, "in their natural state, excepting their loss of colour, and exceedingly well preserved, below a stratum of sand about 14 or 15 feet thick, in a bluish kind of clay or marl quite down to the level of the sea—how much deeper is not known; the height of these cliffs is in many places above 100 feet."

In 1821 Mr. Webster* gave an account of Hordwell Cliff, and described for the first time its freshwater beds, with a view to show that they were a continuation of the same strata which he had so truthfully figured and described in 1816, in Sir Henry Englefield's splendid work on the Isle of Wight.

In 1826 Sir Charles Lyell read a paper† on the Freshwater Strata of Hordwell, Beacon, and Barton Cliffs, and gave an account of the beds and the fossils they contained.

In 1846 Mr. Searles Wood‡ gave an excellent account of the upper marine formation of Hordle Cliff, and a list of the shells found by Mr. Fred. Edwards and himself in that stratum, the existence of which had been overlooked by previous observers. He likewise described the mammals, reptiles, and fishes found

* *Trans. of the Geol. Soc. vol. i. p. 90, second series.*

† *Trans. of the Geol. Soc. vol. ii. p. 287.*

‡ *London Geological Journal, pp. 1 and 118.*

by him, and gave a description of these, and a full list of the shells found in the freshwater beds of this locality.

In 1847 Prof. Owen* described the remains of *Palaeotherium* and *Dichodon*, two new genera of the family *Palaeotheriidae*, discovered by Alex. Pytts Falconer, Esq., near Hordle, and which that gentleman has since presented to the Hunterian Museum. These are the only communications which especially relate to the subject of the present paper, the object of which is to give a stratigraphical account of the different beds and the palaeontological contents of the same.

The strata on this coast have been much denuded; the beds composing the upper freshwater formation are nearly removed, as they have been so likewise to a great extent between Hampstead and Headon Hill in the Isle of Wight. The cliffs are covered with a bed of drift, composed chiefly of rolled flints and other debris derived from the chalk. The drift is disposed in horizontal layers upon the inclined edges of the beds; its thickness in different places varies from 5 to 30 feet. The boulders are loosely cemented together with a matrix of sand and marl. The constant wasting of the cliffs causes the foundering of the drift-bed, and supplies the shore with a superabundance of pebbles. It is probable that from this source Hurst Beach, in ages past and down to the present time, has derived its constantly increasing beds of shingle, which are washed up along this line of coast by the strong tidal currents and heavy seas that set in from the south-west.

The strata are described in a descending order, commencing at the east end of Hordle Cliff at a place called Mine-way; and proceeding towards Beacon and Barton each bed is noted, where it rises on the shore and crops out of the cliff, to which is added a list of its fossil contents.

The beds rise very uniformly at angles varying from 2° to 5° to the horizon, and incline to the east. Their course is interrupted by a considerable denudation at Mead End, and by two small ravines, called "Bunnys," = to the term "Chines" in the Isle of Wight, which means a fissure in the cliff produced by streamlets which form the natural drainage of the land. Beacon Bunny separates Hordle from Barton Cliff and Chuton Bunny—the latter from High Cliff.

* Quarterly Journal of the Geol. Soc. vol. iv. p. 17.

Division of the Strata.

The strata which compose this coast section admit of a division into five groups:—

1. *The upper freshwater.*
2. *The upper marine.*
3. *The lower freshwater and intercalated brackish-water beds.*
4. *The estuary series.*
5. *The Barton or true lower marine strata.*

The Upper Freshwater Formation

consists of alternations of sands, clays, and marls which attain a thickness of about 20 feet.

No. 1. White sand striped with pale yellow bands; rises about a mile to the east of Hordle House, and runs out near Mead End: it is well seen *in situ* near a foot-path up the cliff known as "Paddy's Gap." We found no fossils in this bed: it measures from 6 to 9 feet.

No. 2. Dark greenish marl striped with fawn-colour; contains layers of shells and several bands of lignite from 1 to 2 inches in thickness. The upper shell-seams contain *Paludina lenta*, *Lymnæa longiscata*, and *Melania*. The lower shell-seam contains immense numbers of *Unio Solandri*, with a great quantity of small dark seeds, *Carpolithes ovulum*, Brong., *C. thalictroides*, Brong.: about 3 feet 6 inches.

No. 3. Green marly clay, very tenacious, having in places a bluish tint. The upper part of this bed contains shelly seams.

Paludina lenta.
Melanopsis carinata.
Planorbis lens.

Lymnæa longiscata.
— *fusiformis.*
Cyclas exigua.

The *os calcis* of a mammal of an unknown genus was found here, which is now in the cabinet of the Marchioness of Hastings; the green clay measures about 10 feet.

The Upper Marine Bed.

No. 4. Brownish-yellow sand. This bed was much covered up at its origin, and throughout nearly its entire course, at the time of my visit, and was only exposed at one place, to the extent of about 10 yards. By digging, my collector ascertained that it rises nearly opposite to Milford, and runs out of the cliff a little to the westward of Hordle House. According to Mr. Searles Wood, it rises a few paces westward of a ravine situated half a mile from Milford, and occurs at an elevation of 10 or 12 feet above high-water mark, with a thickness of only 9 or 10 inches, and only traceable for 40 yards. Mr. Frederick Edwards, of Hampstead, so well known for his unrivalled cabinet of Hamp-

shire fossils, was the first, in 1840, to notice this deposit, three years previous to Mr. Wood's visit. At that time Mr. Edwards could trace the bed for 300 yards*. These facts attest the rapid waste going on in this coast. The following list of Testacea is the result of the joint researches of Messrs. Edwards and Wood :—

Actæon.	Melania muricata.
Ancillaria subulata, <i>Lam.</i>	Melanopsis ancillaroides, <i>Desh.</i>
Arca elegans.	— carinata, <i>Sow.</i>
Balanus unguiformis, <i>Sow.</i>	— fusiformis, <i>Sow.</i>
Bulla (two species).	— minuta, <i>Sow.</i>
Cæcum.	Murex sexdentatus, <i>Sow.</i>
Cancellaria muricata.	Mya angustata, <i>Sow.</i>
— elongata.	Mytilus? affinis, <i>Sow.</i>
Cerithium cinctum, <i>Sow.</i>	Natica depressa, <i>Sow.</i>
— margaritaceum, <i>Sow.</i>	— epiglottina, <i>Lam.</i>
— terebrale.	— labellata, <i>Lam.</i>
— ventricosum, <i>Sow.</i>	Nematura, n. sp.
Chemnitzia (two species).	Nerita aperta, <i>Sow.</i>
Corbula cuspidata, <i>Sow.</i>	Neritina concava, <i>Sow.</i>
Cyrena cycladiformis, <i>Desh.</i>	Nucula deltoidea, <i>Lam.</i>
— obovata, <i>Sow.</i>	—, new species.
— pulchra, <i>Sow.</i>	Ostomia subulata.
Cytherea incrassata, <i>Desh.</i>	Ostrea.
— obliqua, <i>Desh.</i>	Planorbis (two species).
Fusus labiatus, <i>Sow.</i>	Pleurotoma (two species).
Hydrobius.	Psammobia compressa, <i>Sow.</i>
Kellia (two species).	Scalaria.
Limnæus.	Serpula corrugata, <i>Sow.</i>
Lucina divaricata, <i>Lam.</i>	— tenuis, <i>Sow.</i>
— pulvinata, <i>Wood.</i>	—, new species.
Melania angulata, <i>Wood.</i>	Turbo?
— fasciata, <i>Sow.</i>	Voluta spinosa, <i>Lam.</i>

From that portion of the bed which was exposed, we collected a considerable number of the species of the above list. The shells are not so well preserved as those of the upper marine bed at Colwell Bay, many of them being largely impregnated with the peroxide of iron. The thickness of the bed exceeds that given by Mr. Wood; but, in other respects, I agree with that excellent observer in regarding it as a true marine stratum intercalated between the stages of the upper and lower freshwater formations.

The Lower Freshwater Formation.

No. 5. Dark stiff clay above, passing into an iron-gray coloured sand below,—the latter richly fossiliferous. The dark clay forms a good tracing line of the bed in the cliff, which inclines at an angle of 2°, and can be seen, *in situ*, with a telescope, from Colwell. It rises on the shore to the east of Hordle-lane End, and crops out about a quarter of a mile east of Mead End. The

* London Geological Journal, p. 2.

upper clay band is about 2 feet in thickness, and the lower sandy stratum about 8 inches.

The clay contains fine specimens of *Unio Solandri*: laminated masses of this band can be traced through the entire bed.

I have before me a mass of the iron-sand resting on the clay; it contains immense numbers of *Melania*, new sp., *Paludina lenta*, *Cyclas exigua*, and a number of bright green-coloured seed-vessels of *Chara* (*Gyrogonites*). These seeds are met with throughout the sand and clay.

No. 6. Green marls and clay; form a conspicuous bed as they rise on the shore eastward of Hordle-lane, and run out of the cliff beyond No. 5. The clay is stiff and tenacious, and is in some parts mottled with red and brown. Contains few shells. *Paludina angulosa* is the only species Mr. Keeping ever recollected obtaining from it. Thin layers of lignite, from 2 to 3 inches in thickness, occur in the upper part. It measures about 12 feet. A bright green marl forms the base of the bed, which is as remarkable for the number of shells it contains, as the upper part of the bed is for its paucity.

No. 7. Bright green marls, which form the base of the preceding, but are distinguished from it by their fossiliferous character, containing immense numbers of *Potamomya gregaria*, which lie in seams. The shells are well preserved, but the valves are mostly separate: the marls measure about 18 inches.

No. 8. Lymnæan limestone, similar to the beds I have described under this name in the Isle of Wight. It rises on the shore, about 200 yards east of Hordle-lane, and forms a well-marked band in the cliff. It is a cream-coloured, pinky, calcareous marl, slightly indurated where it has been exposed for some time to the air, and contains an immense quantity of lacustrine shells, not, in general, well preserved. Many blocks however enclose very good specimens of the following, with the shell entire:—

Lymnæa longiscata, Brong.

— *fusiformis*, Sow.

— *columellaris*, Sow.

— *pyramidalis*, Sow.

Planorbis euomphalus, Sow.

— *rotundatus*, Brong.

— *lens*, Sow.

Several of the above species lie clustered together in a block before me, about 3 inches square. In some parts of its course it contains great numbers of (*Gyrogonites*) *Chara medicaginula*.

Inferiorly this bed reposes on a black carbonaceous clay containing lignite. It is remarkable, that both in these cliffs and in the Isle of Wight, the beds are often separated by lignite bands. The cream-coloured shelly marl measures from 4 to 9 inches in thickness, and the lignite band and clay from 2 to 4 inches.

No. 9. Greenish marly clay, which in that part of the bed exposed to the air hardens into calcareous nodules, which are

stained with the ferruginous salts they contain. In some places these nodules project from the cliff, or are strewn along the shore. This nodular bed has few fossils, and reposes on a green arenaceous marl containing—

Potamomya plana.

Melania.

Cyclas.

Paludina lenta.

Melanopsis brevis.

Neritina, n. sp.

Scales of *Lepidosteus* and *Gyrogonites* (*Chara medicaginula*) are found therein: it measures from 4 to 6 feet.

No. 10. The "Crocodile Bed;" rises to the west of Hordle House, and runs out at Long Mead End. It consists of a fine white sand, very uniform in character, and reduced to the state of an impalpable powder. It is extremely compact in the rock, and is picked with much difficulty.

This is one of the richest beds in the section, and from the circumstance of its containing many skulls and other parts of the skeletons of crocodiles, I have called it the Crocodile Bed; it measures about 5 feet, and contains bones of the following Vertebrata:—

Mammalia.

Palæotherium (Cuvier), nearly a perfect skull and other parts of three species: *P. splenum*, *P. parvum*, and *P. annexens*.

Palæotherium, Owen.

Dichobune, Cuvier.

Microchærus, Wood.

Spalacodon, Charlesworth.

Seal.

Hyænodon (Laizer et Pairvieu).

Birds.

Bones of this class have been found, but the group to which they belong has not been accurately ascertained.

Reptiles.

Crocodylus Hastingsiæ. The Marchioness of Hastings first discovered and described the magnificent fossil skull of this eocene Saurian, which has been recently beautifully figured and faithfully described by Prof. Owen*.

Alligator Hantoniensis. Mr. Searles Wood† has figured the upper jaw and dental series of this reptile, with the femur and vertebræ of the same. The following *Chelonia* have been obtained from this bed:—

Trionyx Henrici, Owen, *Palæontographical Memoir*, tab. xvi.

— *Barbaræ*, Owen,

Ibid.

tab. xvi A.

— *marginatus*, Owen,

Ibid.

tab. xix.

— *rivosus*, Owen,

Ibid.

tab. xviii.

— *planus*, Owen,

Ibid.

tab. xix C.

— *circumsulcatus*, Owen,

Ibid.

tab. xix B.

Emys crassus, Owen,

Ibid.

tab. xxvii.

* Pal. Mem. Eocene Reptiles.

† London Geol. Journ.

To the above list of reptiles must be added bones belonging to an unknown Lizard, and vertebræ of an Ophidian.

The above specimens of *Trionyx* and *Emys* are in the cabinet of the Marchioness of Hastings, and I cannot cite these valuable relics which I had the privilege of attentively studying without at the same time acknowledging her ladyship's courtesy, and bearing my humble testimony to the judgement and skill displayed in restoring the numerous fragments of these Chelonians to their proper places in the skeleton, a task which the Marchioness has achieved with matchless patience, neatness, and tact.

Fishes.

Very perfect specimens of *Lepidosteus* have been found. The dermal scales are very abundant, many of which, with portions of the jaws and teeth, are strewn throughout the bed.

In the cabinet of Lady Hastings are many beautiful specimens of this eocene ganoid fish.

Mollusks.

Potamomya plana, *Potamides margaritaceus*, and *Melania conica* are found sparingly.

The reptilian bones lie chiefly in the lowest 12 inches of the sand, but separate vertebræ and a great number of dermal plates are strewn throughout the entire bed.

No. 11. Light green marl striped with gray, ochre and red tints, containing a few *Potamomya angulata*; fossils not numerous: 5 feet 6 inches.

No. 12. *Gray Sand* passing into dove-coloured white when dry. Contains many seams of shells. The most abundant fossil is *Potamomya plana*. The blocks of this bed that lie along the base of the cliff, split at the shelly layers into slabs of from half an inch to an inch in thickness. The surface of these is covered with single valves of *Potamomya*. It is rare to obtain specimens with the valves united. In this bed are likewise found many fragments of the bones of *Palæotheria* and *Trionycles*. It is remarkable that the osseous *reliquiæ* of this bed are nearly all rounded and much bouldered. It measures about 4 feet.

No. 13. The "Leaf-bed" consists of a slate-coloured clay, which contains the impressions of leaves of Dicotyledonous plants in considerable number and variety of species; it contains likewise fossil fruits and the stems of plants; but we could not discover any shells. This well-marked bed rises nearly opposite Hordle House, and runs out at Long Mead End. Thickness about 18 inches.

No. 14. Bluish sandy clay forms the lowest bed of the fresh-water series, and runs out at Beacon Bunny. This stratum is very uniform in its lithological character throughout. In one part of its course it makes a sudden dip from 3° to 10°. It is tra-

versed by seams of carbonaceous clay, and has numerous zones of lacustrine shells and remains of plants. It admits of a subdivision into minor beds; but in consequence of the debris which covered it, no satisfactory analysis of these could be made. It measures about 20 feet.

Alex. Pytts Falconer, Esq., obtained from this bed the fine specimens of mammalian remains described by Prof. Owen, consisting of the skull, jaws, and many different bones of the skeleton of *Palæotherium*, a new genus of the *Palæotheriidae*, with

Palæotherium (two species).

Dichodon, Owen.

Crocodylus Hastingsiæ.

Trionyx (two species).

Emys.

Lepidosteus, considerable parts of the skeleton.

Paludina lenta.

Planorbis.

Ancylus elegans.

Melanopsis brevis.

Lymnæa longiscata.

— *pyramidalis*.

Melania, n. sp.

Potamomya plana.

Small, black, capsular seeds with a corrugated integument.

Carpolites ovulum, Brong.

C. thalictroides, Brong.

Seeds of *Chara medicaginula*.

No. 15. The "Lignite-bed" rises about half a mile east of Beacon Bunny, and runs out of the cliff about a quarter of a mile west of that gorge, inclining at an angle of 2° . It forms a good line of demarcation in the section. The course of this bed can be traced with a telescope from Colwell, on the opposite shore of the Solent, a distance in a straight line of six miles. It consists of a dark-coloured carbonaceous and very tenacious clay, full of shells, with an intercalated band of lignite about 18 inches in thickness, which has been extracted in some places and burned as coal. The shells lie chiefly at the bottom of the bed. *Potamomya angulata*, *Potamides margaritaceus*, *Melanopsis brevis*, *Neritina concava*, *Cyrena obovata*, *C. Cycladiformis*, *Mytilus Brardii*, a small-ribbed *Modiola*, and *Serpula tenuis* were collected therefrom.

The shells are much crushed, and are preserved with difficulty. Most of my specimens are broken; the contents of the bed were noted on the spot as the fossils were obtained from the rock. The entire bed, which seems to have been formed in brackish water, measures 3 feet 6 inches.

The Estuary Formation.

No. 16. Grayish white sand rises about 300 yards west of Mead End, and runs out at Beacon Bunny, inclined at an angle of 2° . The siliceous particles of this bed are scarcely coherent, and its numerous fossils are consequently not well preserved. It contains an immense quantity of small shells, which are extremely brittle, and very difficult to preserve; specimens of the following genera are now before me:—

Oliva.	Natica.	Venericardia.
Ancilla.	Potamides.	Cytherea.
Pleurotoma.	Cyrena.	Sanguinolaria.
Bulla.	Lucina divaricata.	Potamomya.
Melania.	Corbula.	

A very perfect specimen of a Turtle was discovered in this bed with the carapace and plastron well preserved, but it fell to pieces on being removed from the sand. We collected fragments of the bones of *Chelonia*, and teeth of *Lamna* and *Myliobatis*. The gray sand measures about 5 feet, and passes gradually into No. 17, of which it may be considered to form the upper fossiliferous portion.

No. 17. Fine white sand ; non-fossiliferous : rises on the shore about half a mile east of Beacon Bunny, and disappears beyond Barton Gang. As it passes through Barton Cliff it becomes of a light sulphur-colour, streaked with darker shades, and forms a conspicuous portion of the section, which, when lit up by the sun's rays, presents a beautiful picturesque effect from the water : it measures from 15 to 20 ft.

Nos. 16 and 17 were unquestionably an estuary deposit, as proved by the list of fossils contained therein ; from their stratigraphical position in the series they are the equivalent in the Hampshire section of the Headon Hill sands of Alum and White Cliff Bays in the Isle of Wight. We attach therefore much importance to the analysis of the organic remains they contain, as it throws considerable light on the conditions under which the Headon Hill sands were deposited.

The shelly fragments contained in the latter beds are in such a broken and rounded condition that it is impossible to decide to what genera they belong. In my paper on the Isle of Wight it was observed in reference to these beds, that "the white and yellow sands at Alum Bay, immediately overlying the Barton group, were probably of estuary origin. The absence of organic remains leaves a doubt upon the subject. The equivalent bed however at Beacon Cliff on the Hampshire coast, which shall be more particularly described in a future communication, contains a large quantity of estuary shells mixed with true marine genera, together with the bones of turtles and the teeth of sharks." Guided by these facts, we infer "that the white and yellow sands of Headon Hill were the great estuary deposit which introduced the lacustrine conditions under which the lower freshwater group, with the other intercalated estuary beds, were deposited."

The Lower Marine Formation.

No. 18. Tea-green coloured clay ; rises on the shore near Mead End, about a quarter of a mile east of Beacon Bunny, and

runs out of the cliff near Barton Gang, where it thins out in a singular manner. It is seen "*in situ*," forming the walls of the ravine called Beacon Bunny, where it is capped with the gray sand No. 17. It measures about 25 feet. The fossils are distributed throughout the entire bed. The nacreous laminæ of the bivalves, and the enamel of the *Olivæ* are finely preserved. It differs lithologically from all the other beds in the section, and forms the uppermost true marine stratum of the Barton group. We collected from this clay the following shells:—

<i>Avicula</i> , n. sp.	<i>Tellina lævis</i> , Edw.
<i>Cardium turgidum</i> , Sow. Very large specimens.	<i>Ancillaria subulata</i> , Lam.
<i>Cytherea transversa</i> , Sow.	<i>Buccinum lavatum</i> , Sow.
<i>Corbula</i> .	— desertum.
<i>Mactra</i> .	<i>Natica striata</i> , Sow.
<i>Nucula trigona</i> , Sow.	— patula, Lam.
<i>Venericardia globosa</i> , Sow.	<i>Oliua Branderi</i> , Sow.

Bones of fishes and fragments of the skeleton of a large Turtle have been found in this bed, along with pine-cones, and other vegetable debris.

No. 19. Gray sand rises to the west of Beacon Bunny, and runs out of the cliff beyond Barton Station. No fossils have hitherto been found therein. It measures about 20 feet.

No. 20. The Barton gray sand, or "Chama bed," rises on the shore, about half a mile to the eastward of Beacon Bunny, and runs out of the cliff half a mile west of Barton Station. It is much concealed by the shingle of the beach, which requires to be removed before the bed can be worked. From this rich stratum many fine shells are collected. It contains an immense profusion of *Chama squamosa*, from which circumstance I have named it the "Chama bed." Much difficulty was experienced in measuring this bed, which varies from 10 to 15 feet in thickness. Where the sand rises on the beach it is concealed by shingle, and in its course through the cliff it is covered up by the debris of other beds. The most beautiful specimens of the Barton shells are obtained from this rich fossiliferous stratum. We collected the following species from the gray sand, and have little doubt that future investigations will add many more to the list. The majority of the species are special to it.

CONCHIFERA.

<i>Arca Branderi</i> , Sow.	<i>Chama squamosa</i> , Brand.
<i>Avicula Bartonensis</i> *, Wright MSS.	<i>Corbula cuspidata</i> , Sow.
<i>Balanus</i> .	— longirostrata, Desh.

* The new species named in this paper will be described in a future communication to the Club.

- Corbula exarata*, *Desh.*
Crassatella plicata, *Sow.*
Clavagella coronata, *Sow.*
Cytherea transversa, *Sow.*
 — *obliqua*, *Desh.*
 — *rotundata*, *Brand.*
 —, new species.
Hemicardium Bartonienae, *Wright MSS.*
Modiola tenuistria, *Mill.*
Lucina mitis, *Sow.*
Mactra depressa (var.), *Desh.*
Nucula similis, *Sow.*
 — *minima*, *Sow.*
- Nucula trigona*, *Sow.*
Ostrea flabellula, *Lam.*
Panopæa rugosa, *Edwards.*
Pecten carinatus, *Sow.*
Pectunculus costatus, *Sow.*
 — *Plumsteadiensis*, *Sow.*
Solen gracilis, *Sow.*
Tellina Hantoniensis, *Edw.*
 — *lamellulata*, *Edw.*
 — *squamula*, *Edw.*
 — *lævis*, *Edw.*
 — *ambigua*, *Sow.*
 — *scalaroides* (var.), *Lam.*
Venericardia, near *imbricata*?, *Desh.*

GASTEROPODA.

- Actæon simulatus*, *Brand.*
Ancillaria turritella, *Sow.*
Buccinum junceum, *Sow.*
 — *canaliculatum*, *Sow.*
Bulla attenuata, *Sow.*
Cerithium hexagonum, *Lam.*
Conus dormitor, *Brand.*
Cypræa Bartonienae, *Wright MSS.*
Fusus bulbiformis, *Lam.*
Mitra scabra, *Sow.*
 — *parva*, *Sow.*
Murex frondosus, *Sow.*
Natica ambulacrum, *Sow.*
- Pleurotoma priæca*, *Brand.*
 — *colon*, *Sow.*
Rostellaria rimosa, *Brand.*
Seraphs convolutus, *Montf.*
Strombus Bartonienae, *Sow.*
Solarium canaliculatum, *Sow.*
Triton argutus, *Brand.*
Trochus monilifer, *Lam.*
Voluta costata, *Sow.*
 — *lima*, *Sow.*
 — *Magorum*, *Sow.*
 — *spinosa*, *Lam.*
 — *undulata*, *Wright MSS.*

ZOOPHYTA.

- Turbinolia Bowerbankii*, *Milne-Edwards.*
 — *Fredericiana*, *Milne-Edwards.*
- Turbinolia humilis*, *Milne-Edwards.*
 — *firma*, *Milne-Edwards.*
Lunulites radiata, *Lamarck.*

No. 21. The Barton clay; rises on the shore about half a mile west of Beacon Bunny near Barton Gang, and runs out of the cliff about a quarter of a mile westward of Chuton Bunny, nearly half a mile to the eastward of High Cliff Castle. It attains a thickness of about 40 or 50 feet. An accurate measurement of this bed could not be obtained in consequence of the debris which covers it. It contains the greater number of the fossils known as "Barton shells," with teeth of *Squalus*, *Lamna*, and *Myliobatis*.

CONCHIFERA.

- Arca appendiculata*, *Lam.*
Cardium porulosum, *Brand.*
Clavagella coronata, *Desh.*
Corbula globosa, *Sow.*
 — *pisum*, *Sow.*
 — *revoluta*, *Sow.*
 — *striata*, *Lam.*
- Crassatella sulcata*, *Brand.*
Cytherea elegans, *Lam.*
 — *suberycinoides*, *Desh.*
 — *tellinaria*, *Lam.*
Ostrea oblonga, *Brand.*
Pinna margaritacea, *Lam.*
Venericardia globosa, *Sow.*

M

GASTEROPODA.

<i>Actæon crenatus</i> , Sow.	<i>Murex defossus</i> , Sow.
— <i>elongatus</i> , Sow.	— <i>minax</i> , Brand.
<i>Bulla constricta</i> , Sow.	<i>Natica Hantoniensis</i> , Pilk.
— <i>elliptica</i> , Desh.	<i>Nummulites elegans</i> , Sow.
— <i>filosa</i> , Sow.	— <i>variolaria</i> , Lam.
<i>Cancellaria evulsa</i> , Sow.	<i>Pecten reconditus</i> , Sow.
— <i>quadrata</i> , Sow.	<i>Pleurotoma brevisrostra</i> , Sow.
<i>Conus lineatus</i> , Sow.	— <i>colon</i> , Sow.
— <i>scabriculus</i> , Sow.	— <i>comma</i> , Sow.
<i>Dentalium acuminatum</i> , Sow.	— <i>conoidea</i> , Brand.
— <i>nitens</i> , Desh.	— <i>exorta</i> , Brand.
— <i>striatum</i> , Sow.	<i>Pyrula Greenwoodi</i> , Sow.
<i>Fusus acuminatus</i> , Sow.	— <i>nexilis</i> , Lam.
— <i>asper</i> , Sow.	<i>Rostellaria macroptera</i> , Lam.
— <i>bulbiformis</i> , var.	— <i>rimosa</i> , Sow.
— <i>carinella</i> , Sow.	<i>Scaloria acuta</i> , Sow.
— <i>errans</i> , Sow.	— <i>interrupta</i> , Sow.
— <i>ficulneus</i> , Lam.	— <i>reticulata</i> , Sow.
— <i>interruptus</i> , Sow.	— <i>semicostata</i> , Sow.
— <i>longævus</i> , Lam.	<i>Serpula crassa</i> , Sow.
— <i>porrectus</i> , Brand.	<i>Solarium plicatum</i> , Lam.
— <i>regularis</i> , Sow.	<i>Terebellum fusiforme</i> , Lam.
<i>Gastrochæna contorta</i> , Lam.	<i>Trochus agglutinans</i> , Desh.
<i>Hipponyx squamiformis</i> , Lam.	<i>Typhis fistulosus</i> , Broc.
<i>Infundibulum obliquum</i> , Sow.	— <i>pungens</i> , Brand.
— <i>trochiforme</i> , Sow.	<i>Voluta ambigua</i> , Sow.
<i>Littorina sulcata</i> , Pilk.	— <i>athleta</i> , Sow.
<i>Murex asper</i> , Brand.	— <i>costata</i> , Sow.
— <i>bispinosus</i> , Sow.	— <i>luctatrix</i> , Sow.*

No. 22. Greenish tenacious clay; rises on the shore near Barton Station, and runs out of the cliff near High Cliff Castle. It contains a few shells, and the teeth and bones of fishes, and measures about 20 feet.

No. 23. The High Cliff sands and clays rise on the shore a quarter of a mile to the eastward of Chuton Bunny, and run out of the cliff about a quarter of a mile to the westward of High Cliff Castle. This bed is composed of alternations of sand and clay, of brown, green, and ferruginous colours. It is very rich in beautiful shells, as *Cassidaria coronata*, *C. carinata*, with many other species, and contains numerous nodular masses made up entirely of fossils, but my materials do not at present enable me to give a correct list of these. This bed attains a thickness of from 20 to 30 feet.

No. 24. Green clay; rises on the shore at Chuton Bunny, and

* The British Natural History Society, of which Mr. Charlesworth of York is Secretary, has distributed amongst its members a very complete suite of the fossils of the above lists. A series of these shells, including 100 species, is supplied for a small subscription.

- runs out of the cliff nearly half a mile westward of High Cliff Castle. It contains the bones and jaws of fishes, with many broken shells. It attains a thickness of about 30 feet. The fossils are nearly all in a fragmentary state. This green clay forms the lowest bed of Barton Cliff.

On the Cidaridæ of the Oolites, with a description of some new species of that family. By THOMAS WRIGHT, M.D. &c.

READ 24TH JUNE 1851.

THE Echinoderms form the highest class of the radiated animals ; it includes organisms which are either fixed or free, composed of a regular but very complicated skeleton, secreted by and inclosed within organized membranes, and often preserved in admirable perfection in the fossiliferous strata of all periods of the earth's history. The study of this class, although hitherto much neglected by geologists, presents many points of importance to the progress of their science, for the test of Echinoderms exhibits characters of more import and significance than those afforded by the shells of Mollusca. Unlike the testaceous covering of that class, the test of Echinoderms constitutes an internal and integral part of the animal, participating in its life, intimately connected with the organs of digestion, respiration and generation, as well as with those of locomotion and vision, and having in consequence many of the distinctive characters of the organism impressed upon it.

In all Echinoderms, the external parts of the body, with the organs of locomotion, are disposed around a common centre ; in the spherical forms they are arranged in rows like the lines of longitude on a terrestrial globe, and the mouth and the anus are situated at the opposite poles : the elements of the body are repeated several times in the composition of the skeleton.

It has been shown by M. Agassiz* that the radiated type of structure observable in this class can be resolved into a modification of the bilateral symmetry seen in the higher groups of the animal kingdom. The elements of the skeleton are arranged on two sides of a median line. If we take for example the *Spatangus purpureus*, we observe that the test is elongated in the direction of the line which connects the mouth with the anus ; the mouth being situated at the base and nearer the anterior border of the test, whilst the anus occupies an elevated position on the posterior border. Were we to make a transverse section of the *Spatangus*, we should have an oral or anterior half, and an anal

* Prodrôme d'une Monogr. des Echin., Mém. Soc. de Neuchâtel, tom. i. p. 168.

or posterior half; whilst, on the contrary, were we to split the test asunder in the line of its long diameter, we should have the right half and the left half of the body. The five ambulacral aræ are unequal. The anterior area is not identical with either of the others; the first pair are symmetrical, but differ from the second pair, which are likewise symmetrical; the bilateral symmetry of these oblong Spatangoidæ is therefore very evident. In the globular forms of Cidaridæ, however, a more careful study is requisite to make the demonstration complete. In them the test is formed of polygonal plates united together by sutures and divided into ten segments, of which five are named ambulacral aræ, and five interambulacral aræ, each area being formed of two columns of plates; the ambulacral and interambulacral aræ alternate with each other, and are separated by ten zones of small plates perforated for the passage of tubular retractile organs connected with locomotion and respiration, and forming the poriferous avenues.

The test of *Echinus sphaera* is composed of twenty distinct zones of elementary parts, which are narrow at the summit, from whence they divide in rays, and gradually increase in width towards the circumference or equator, where they are widest; they again contract as they approach the mouth, which occupies the base. The symmetrical disposition of these elementary zones occasions the radiated form which characterizes the Cidaridæ. Besides the plates of the ambulacra, interambulacra, and poriferous avenues, the summit of the test is furnished with a circle of plates surrounding the anus, composed of five larger plates in relation with the generative organs, and called ovarian, and five smaller plates disposed between them, in which are lodged the organs of vision, and called ocular; each of the ten plates is perforated with a small hole for giving passage to the genital ducts and for lodging the eyes. This anal circle of plates is called the apical rosette or disc.

The ovarian plates occupy the summit of the interambulacral aræ, and the ocular plates the summit of the ambulacral aræ; the ovarian plates are not all of equal size or of the same structure; one is larger and more prominent than the others, presenting a spongy porous surface, and called the madreporiform plate; it is placed opposite the ambulacra, which is the analogue of the anterior area in the *Spatangus*, and occupies therefore the posterior border of the apical disc, affording thereby a key for ascertaining the antero-posterior diameter of the body; the other four ovarian plates are disposed in pairs before the single madreporiform plate. The polygonal plates of both aræ are arranged in double vertical rows, two columns of ambulacral plates alternating with two columns of interambulacral plates; the plates of each pair

are united by a zigzag suture formed by the re-entrant angles of the plates; the plates of the ambulacra are united to those of the interambulacra by minutely serrated edges. The poriferous zones have small plates, the sutures of which cut through the centre of the holes, by which arrangement the enlargement of the foramina with the growth of the test is provided for.

The surface of the test is covered with tubercles for supporting spines; these are of two kinds, the principal and the miliary tubercles. The principal tubercles are in general raised on mammillated eminences with or without crenulations at their summit, and arranged in vertical rows on the sides of the aræ between the mouth and the anus. The miliary tubercles are much smaller and more numerous; they are not disposed with the same regularity, but are frequently scattered on the surface of the plates, or disposed in circles around the bases of the principal tubercles.

Each tubercle supports a spine, the size of which corresponds with that of its tubercle; the spines are composed of three distinct parts, the stem, the neck, and the articular head. The stem is more or less elongated and of various forms; the head is surrounded by a raised ridge, and has a concave excavation for its articulation with the tubercle; the head is separated from the stem by a smooth neck, the extent of which varies in the different species. The spines present very numerous modifications of size, form and sculpture, which are closely connected with specific distinctions; some are elongated, cylindrical, fusiform, or subulate; others are compressed, spatuliform, or triangular; whilst others, on the contrary, are expanded, pyriform or claviform.

The surface of the spines is smooth, striated, or furnished with granules, prickles, or other asperities disposed in regular order or scattered at hazard over the stem. The same individual has its test occupied with different kinds of spines; hence the great importance of obtaining these appendages in connection with the test.

We have made the following estimate of the number of separate pieces which enter into the composition of the test of *Echinus sphaera*:—

Interambulacral aræ	32 plates in each column	$32 \times 2 \times 5 =$	320 plates.
Ambulacral aræ	80 do. do.	$80 \times 2 \times 5 =$	800 do.
Poriferous avenues	160 do. do.	$160 \times 2 \times 5 =$	1600 do.
Apical disc	10 plates		10 do.
Each interambulacral plate supports	10 tubercles	$320 \times 10 =$	3200 tubercles.
Each tubercle supports	a moveable spine		3200 spines.
Each ambulacral plate supports	2 tubercles ...	800×2	1600 tubercles.
Each tubercle supports	a moveable spine		1600 spines.
There are	70 rows of holes in each avenue, and in each row these six holes are disposed in pairs obliquely	$70 \times 6 \times 10 =$	4200 foramina.

The mouth in the Cidaridæ is situated at the centre of the basal surface, and provided with five jaws, each armed with a long tooth; the jaws are united by ligaments and moved by numerous muscles belonging to the voluntary class.

According to Prof. Brunner, the analysis of the test of *Echinus lividus* gave the following result as its chemical composition:—

Carbonate of lime	96·27
Sulphate of lime	1·53
Carbonate of magnesia . . .	0·93
	98·73

The fracture of the test and the spines presents a peculiar crystalline surface altogether unlike that of the external skeleton of other Invertebrata, depending probably on the manner the salts of lime and magnesia are deposited in the cells of the animal basement membrane. The external and internal surfaces of the test are covered by organized membranes, which extend through the sutures and invest the spines and pedicellariæ, and are the producers and the sheath of the test and its appendages.

The mode by which the spheroidal test of an Urchin maintains its original form, whilst it increases in all directions, is easily understood after what we have stated relative to its composition. The viscera of the animal are inclosed in this fragile and inflexible globular crust, which is never shed like the external skeleton of the Crustacea, but grows by a process which has some analogy with the expansion of the skull in the vertebrate classes. By the division and subdivision of the hollow globe into a number of elements inclosed between two layers of membrane, additions are made to the periphery of the plates, whereby they are enlarged and increase in thickness in proportion to the requirements of the animal, so that the form of the test is maintained and its expansion provided for at the same time: the difference between the test of a young and an old Urchin chiefly consists in the number and size of the plates entering into the composition of the same. The new plates are developed around the oral and anal poles, but chiefly near the latter region, where we may observe in young Urchins small plates loosely connected together and supporting incomplete spines.

The numerous genera of the family Cidaridæ are distributed by M. Agassiz into four groups:—

1. THE CIDARIDÆ are characterized by their thick test, nar-

row ambulacra, and large principal tubercles in the interambulacral areæ.

2. THE SALENIANS are characterized by the development of their apical disc, and the presence of an additional central or suranal plate in the same.

3. THE ECHINIDÆ have a thin test, and numerous small principal tubercles in the ambulacral and interambulacral areæ.

4. THE ECHINOMETRANS have an elongated oblong form in a direction oblique to the antero-posterior diameter of the test.

Family CIDARIDÆ*.

Form circular. Mouth central, situated at the inferior pole, closed by a buccal membrane which is either naked or covered with granules. Anus opposite the mouth, opening in a ring composed of ten plates, five of which appertain to the genital, and five to the visual organs. The antero-posterior diameter is indicated by the median madreporiform body which becomes united to the single ovarian plate. The plates of the test support tubercles disposed in regular order for carrying moveable spines of various forms, some of which are proportionably large. The organs of mastication consist of five jaws, each armed with a long tooth. This framework is articulated to the test by several arched processes called auricles.

Genus CIDARIS, Lamk.

Form circular, test thick, flattened at both poles. Ambulacral areæ narrow, about one-fourth the diameter of the interambulacral areæ, and covered with small close-set granules. Pores disposed in simple pairs. The principal tubercles in the interambulacral columns are perforated, and carry large heavy spines which are smooth or furrowed, spiny or granular. The ovarian plates are large, pentagonal and equal; the ocular plates are small and triangular, and wedged between the ovarian. The mouth is circular and without indentations; the buccal membrane is covered with imbricated scales upon which the ambulacral pores extend. Jaws powerful, composed of five pyramids, the branches of which are not united at their summits. Teeth channelled, not carinated on their internal surface. This genus admits of a na-

* The group of Cidaridæ includes six genera: *Cidaris*, Lam., *Goniocidaris*, Desor, *Hemicidaris*, Agass., *Acrocidaris*, Agass., *Acropeltis*, Agass., *Palæocidaris*, Agass.

tural division into two types; in the one the tubercles are smooth, in the other they are crenulated at their base.

The first type.—*Tubercles with the base not crenulated. Are found in our present seas, and fossil in the carboniferous, triassic, cretaceous, and tertiary rocks. They are not found in the Oolitic strata, to which group the present paper is restricted.*

The second type.—*Tubercles with the base crenulated. Comprehends oolitic and triassic forms.*

The circular mouth without indentations serves to distinguish the genus *Cidaris* from the genus *Hemicidaris*. The form of the ambulacral aræ, the number and arrangement of the granules on the same, the size of the tubercles, and the number of their crenulations afford good specific characters. The ovarial and ocular plates are seldom preserved. The lantern and teeth ought to be carefully studied, as they are sometimes found detached; the spines likewise yield good specific characters, but they are seldom preserved along with the test.

Cidaris Fowleri, Wright, n. sp. Pl. IV. fig. 5 a, b, c.

Test spheroidal, depressed at both poles; ambulacral aræ flat, narrow and undulated, furnished with two rows of small, regular marginal granules and two rows of central blunt irregular microscopic granules; poriferous avenues wide; pores oblong and distant; interambulacral aræ furnished with two rows of from 8–10 principal tubercles; intertubercular spaces wide and covered with small granulations; spines large, with irregular forward-directed prickles.

Height 1 inch $\frac{1}{10}$ th, transverse diameter 1 inch and $\frac{8}{10}$ ths. Specimens from the upper stages of the *Oolites* measure in height 1 inch and $\frac{8}{10}$ ths, transverse diameter 2 inches and $\frac{8}{10}$ ths.

Description.—This beautiful Urchin has been catalogued as *C. coronata*, but it presents characters very distinct from that form; a fact which has been ascertained by comparing *C. Fowleri* with the typical specimens of *C. coronata* in the British Museum: the latter species has hitherto been found only in France, Germany, and Switzerland, and figured in the works of Goldfuss, Agassiz, and Cotteau. In the Swiss Jura *C. coronata* characterizes the terrain à chailles, a local formation, the greatest similarity to which exists palæontologically with the lower calcareous grit of Yorkshire; in l'Albe Wurtembergeoise it appertains to the Coral-line Oolite.

The ambulacral aræ of *C. Fowleri* are slightly serpentine and

ribbon-shaped, and nearly of a uniform breadth throughout. The poriferous avenues are broad; the pores are oblong and set in pairs in a single file at short distances apart. The areæ are flat, slightly raised, and have four rows of granules; the external rows consist of larger granules, which range regularly on the margins of the areæ; the internal rows consist of small, flat, almost microscopic granules; there are fifteen pairs of holes opposite each of the large tubercular plates.

The interambulacral areæ are formed of broad plates; the zig-zag median sutural line is very clearly defined; each column contains from eight to ten primary tubercles, so that the test of this Urchin supports from 80 to 100 large spines. Each plate is occupied with a smooth areola slightly furrowed at its circumference and raised into a boss towards the centre. The summit of the boss is sculptured with fifteen deep crenulations; from the boss arises a short cylindrical stem terminated by a small hemispherical deeply perforated spinigerous tubercle, the diameter of which exceeds a little that of its stem; the margin of each areola is bounded by a circle of fifteen prominent granules, some of which from the equator to the anal pole are raised upon broader bases. There is a granular circle around each areola, but from the equator to the buccal pole one row of granules is common to two areolæ. The interareolar spaces are covered with small close-set granules of two different sizes. The mouth is large, and is half the diameter of the test at the equator. In the specimen before me the five strong pyramids of the lantern are armed with conical triangular teeth *in situ*. The anal disc was broken in all the specimens hitherto found.

The spines are never seen attached to the test, but in the same bed and lying near some of these Urchins, long cylindrical slightly flattened spines have been found about $1\frac{1}{2}$ inch in length and from 2 to 3 lines in diameter, with a crenulated base, short neck, and having the surface of the flattened stem covered with short sharp prickles, the points of which are directed forwards; these spines most probably belonged to *C. Fowleri*, as it is the only Urchin found in the same bed whose test could support such large spines (fig. 5 c).

Affinities and differences.—*Cidaris Fowleri* resembles *C. Blumenbachii* in the general form and structure of the test, but it differs from that well-known species in the flatness of the ambulacral areæ, in the greater breadth of the poriferous avenues, and in having a greater number of plates in the interambulacral columns; the granulated space between the principal tubercles is wider, and the granular wreath encircling the areolæ is likewise composed of smaller granules. It differs from *C. Parandieri*, Ag., in having a greater number of tubercular plates in the

interambulacral arææ. It resembles *C. maxima*, Goldf., in the general outline of the test, the width of the granular spaces between the tubercles, and in the spines supposed to belong to *C. Fowleri* being armed with short forward-directed prickly processes like those of *C. maxima*. It differs from *C. propinqua* in having a greater number of plates in the interambulacral arææ.

Locality and stratigraphical range.—*Cidaris Fowleri* was obtained from the ferruginous beds of the Pea-grit at Crickley Hill. I have dedicated this beautiful species to my friend Charles Fowler, Esq., who obtained two fine specimens from this locality, and to whose generosity I am indebted for the one which has served for my description and enriches my cabinet.

Cidaris Blumenbachii, Munster.

SYN. *Cidarites Blumenbachii*, Munst. ; Goldfuss, Petref. Germaniæ, t. 39. p. 117.

Cidaris Blumenbachii, Agassiz, Echin. Foss. 2nd part, t. 21. p. 61 ; Park. Org. Rem. vol. iii. t. 4. fig. 15.

Cidaris florigemma, Phillips, Geol. of York. t. 3. fig. 12.

Cidarites Blumenbachii, Munst. ; Cotteau, Etudes Echin. Foss. t. 10. p. 108.

Test circular, inflated at the sides and depressed at the poles ; ambulacral arææ narrow, elevated, undulated, and furnished with four rows of granules ; interambulacral arææ with two rows of from six to seven tubercles ; areolæ approximated, elliptical and excavated, and surrounded by a circle of small tubercles ; spines large, thick, subcylindrical, and ornamented with longitudinal rows of granules ; neck short and smooth.

Height 1 inch and $\frac{4}{10}$ ths, transverse diameter 2 inches ; spines 1 inch and $\frac{8}{10}$ ths in length, and $\frac{4}{10}$ ths of an inch in diameter.

Description.—This typical species was very abundant in the seas which deposited the Coralline Oolites of Europe. It has a globular form considerably depressed at the poles ; the ambulacral arææ are narrow, nearly of a uniform breadth throughout ; they are much undulated and furnished with four rows of granules ; the external rows are larger, more regular and prominent, and more developed towards the base than the internal rows. The poriferous avenues follow the undulations of the arææ ; they are narrow, and lie in a groove formed by the prominent granules of the ambulacral and the external marginal granules of the interambulacral arææ. The interambulacral arææ are five times as wide as the ambulacral, and are occupied with two rows of large prominent tubercles from six to seven in each row, which are supported on large mammillary eminences gradually rising from smooth elliptical areolæ. The mammæ at their summits

are sculptured with from 18–20 crenulations, and the areolæ are separated from each other by a circle of granules made more prominent, inasmuch as they are raised on oval elevations of the test. The principal tubercles are small and closely set together at the base, but at the equator, and always at the upper part of the test, they become largely developed; the narrow central space between the ranges of the large tubercles is occupied with an abundant granulation, the granules of which are smaller, however, than those encircling the areolæ.

The mouth is armed with powerful jaws and teeth, which are not, however, preserved in the specimens before me; the apical disc is unknown.

The spines attain a great size; they have an elongated thick subcylindrical form which suddenly expands above the neck, and then gradually tapers towards the apex; their surface is covered with small granulations, very uniform in size and disposed in longitudinal rows; the tubercles of the adjoining rows alternate, and each series is connected by a filament which passes from one tubercle to another; at the summit of the spine the granules become elongated, and expand to form a radiated star-like disc; the neck of the spine is short and smooth, the articulating head is small, and the rim of the acetabulum is encircled with crenulations.

Affinities and differences.—*C. Blumenbachii* is distinguished from *C. Fowleri* in the extreme narrowness of the ambulacral areæ, the size and prominence of the granules which cover the same, and in the closer approximation of the pairs of pores in the avenues. The interambulacral areæ are wider, whilst the central granular space between the tubercles is narrower; there are fewer ranges of tubercles in the areæ, and the areolæ are encircled by much larger granules; but it is in the structure of the spines that the greatest difference is observed: instead of the well-known regular form of the tubercles so constant in the spines of *C. Blumenbachii*, the spines of *C. Fowleri* are compressed and covered with irregular rows of prickles.

Locality and stratigraphical range.—This Urchin is very characteristic of the Coralline Oolites of Wilts, Oxfordshire, and Yorkshire; we have never seen it either in the Inferior or the Great Oolite; our specimens are from the Coral Rag of Wiltshire; it occurs in France in the corallian stages of Châtel-Censoir and Druyes and in the environs of Tonnerre, and at Bailly and at Courson*. In Germany it was found at Thurnau and Muggendorf†; in the coralline Oolite of Hildesheim in the kingdom of Hanover‡; in Switzerland in the terrain à chailles of Fringelli,

* Cotteau, Echin. Foss. p. 110. † Goldfuss, Petr. Germaniæ, p. 117.

‡ A. Roemer, Norddeutsches Oolithen Gebirge.

Wahlen, and Gunsberg in the canton of Soleure, and in the white corallian of Hoggerwald*.

History.—This beautiful species was long ago figured by Parkinson in his 'Organic Remains,' afterwards it was most accurately figured and described by Goldfuss in his 'Petrefacta,' and subsequently by Agassiz, Phillips, and Cotteau, in their respective works.

Cidaris propinqua, Münster. Pl. IV. fig. 6.

SYN. *Cidarites propinquus*, Münst.; Goldfuss, Petrefact. German. p. 119. t. 40. fig. 1, 2; Agassiz, Prodr. Echin. p. 21; Echinoderm. Foss. Suisse, p. 62. t. 21. fig. 5–10; Desmoulins, Tabl. Synop. p. 328. No. 17.

Cidaris monilifera, Agassiz, Catal. Syst. Ectyp. Neoc. p. 9.

Cidaris coronata, var. *minor*, Agassiz and Desor, Cat. raisonné des Echinides; Cotteau, Echinides Foss. du Départ. de l'Yonne, p. 104.

Test thick, circular, and depressed at the poles; ambulacral aræ narrow, sinuous, and furnished with two rows of small round prominent granules; interambulacral aræ with two rows of large prominent tubercles, six in each row, raised on small mammillary eminences with smooth summits; "spines with a short neck and a thick granulated stem;" apical disc unknown.

Height $\frac{6}{10}$ ths of an inch, transverse diameter 1 inch.

Description.—This Urchin resembles in many points the preceding species, but exhibits characters very distinct from it. The ambulacral aræ are extremely narrow and serpentine, having two rows of small prominent granules arranged on the margins of the aræ, with a few central microscopic ones between them about the equator. The pores are placed in rather deep winding avenues, closely and obliquely together in single pairs. The interambulacral aræ are nearly five times the width of the ambulacral, and furnished with two rows of tubercles, six in each row; they are large, prominent, slightly perforated, and nearly spherical; the mammillated eminences on which they are supported being disproportionately small, and having smooth and convex summits, unlike the crenulated summits observed in the mammæ of other Oolitic *Cidaridæ*. The specimen before us is too much injured to enable us to state whether any rudimentary sculpture surrounds the summits of the mammæ on the superior surface of the test, as is the case in the Swiss and German specimens. The areolæ are shallow and nearly of a circular form, their margins being encircled by a wreath of twelve small round prominent granules supported on little eminences, and forming a distinct beaded boundary for each tubercle. The median space down the centre of the aræ is slightly concave, and filled with

* Agassiz, Echin. Foss. Suisse.

granules of a much smaller size than those encircling the margins of the areolæ. The mouth-opening is circular and about one-half the diameter of the test at the equator; the tubercles surrounding the mouth are well developed, but smaller than those occupying the middle and upper part of the test. The apical disc is absent, but the space which it filled is of considerable diameter. The spines have not been met with in our locality.

Affinities and differences.—*C. propinqua* so nearly resembles *C. coronata*, that although it was described as a distinct species by Agassiz in his 'Echinoderm. Foss. de la Suisse,' it was afterwards grouped as var. *minor* of *C. coronata* in the 'Catalogue raisonné des Echinides*' of the same author. The test of this Urchin has unquestionably a very close resemblance to *C. coronata*, but a fact mentioned by Goldfuss should not be overlooked; he found peculiar spines associated only with *C. propinqua*, which never occurred with *C. coronata*†. The extreme narrowness of the ambulacral areæ with the two marginal rows of granules likewise distinguish it from *C. coronata*, which has six rows in the same areæ. In the absence of crenulations from the mammillary eminences on the lower part of the test, together with the bead-like granular circle around the areolæ, it resembles *C. coronata*. Not having a specimen of that species in our cabinet with which to compare the specimen before us, we are unable to pursue the comparison further.

Locality and stratigraphical range.—Whilst searching the Pea-grit of Crickley Hill to find a more perfect specimen of *Goniopygus* for Mr. Baily to figure, I discovered *C. propinqua*, having only seen a defaced specimen once before from the same bed and locality, which was too much worn to be identified. We have never seen this species in any collection of Inferior Oolite fossils, and from the pains we have taken to ascertain the different species found in the Cotteswold Hills, it must be rare; it occurs in the Stonesfield slate at Eyeford, but is very rare‡. In Germany it was found by Count Münster in the Baireutheschen Jurakalke, principally in the vicinity of Streitberg§. In Switzerland it occurs in the Terrain à chailles in the environs of Besançon, Bâle, Randen, and Sirchingen||. In France it was collected by M. Cotteau from the corallian stage at Druyes, but always in the state of moulds, the specimens being of small size and having very narrow ambulacral areæ¶.

* Annales des Sciences Nat. tom. vi. 3rd series, p. 331.

† Goldfuss, Petrefact. part 1. p. 120.

‡ Sir R. Murchison, Geol. of Cheltenham, 2nd ed., by Buckman and Strickland, p. 68.

§ Goldfuss, Petrefact. German. part 1. p. 120.

|| Annales des Sciences Nat. tom. vi. 3rd series, p. 331.

¶ Echinides Foss. du Départ. de l'Yonne, p. 106.

History.—First figured and described by Goldfuss in his 'Petrifactiones Germaniæ,' and afterwards by Agassiz in his 'Description des Echinodermes Foss. de la Suisse,' and now figured and described as a British fossil from the Inferior Oolite near Cheltenham for the first time.

Genus HEMICIDARIS (Agassiz).

Test subglobose, more or less flattened at the poles. Ambulacral aræ narrow and sinuous, furnished with primary tubercles on the lower fourth part of each area, which suddenly diminish into small tubercles or granules above, set more or less closely together like those in the aræ of *Cidaris*. Interambulacral aræ much larger than the ambulacral, widest at the equator of the test and narrowest at the poles; around the circumference of the mouth they are about the same breadth as those of the ambulacral aræ.

The primary tubercles of the interambulacral aræ are raised upon large prominent mammillary eminences, having a crenulated margin encircling the base of the tubercle; the equatorial plates carry the largest mammillary eminences. Pores biserial, except near the mouth, where they are triserial. Mouth large, with decagonal indentations around its circumference. Anus central, surrounded by a solid circle of ten plates which are often well preserved. The five ovarian plates are larger and perforated at their summits. The single or madreporiform plate is the largest; it has a more porous structure, and is differently sculptured from the pairs of plates. The five ocular plates are small and triangular: both ovarian and ocular plates are covered with minute granulations.

Spines of two orders: the primaries are long, cylindrical, and mostly of considerable dimensions, the secondaries are small and compressed. This genus differs from the true *Cidaris* in the bases of the ambulacral aræ supporting primary tubercles. *Hemicidaris* thus forms a type of structure intermediate between *Cidaris* and *Diadema*. In *Hemicidaris* the mouth is decagonal, in *Cidaris* it is circular.

All the species are fossil, and characterize the middle and upper stages of the oolitic rocks. Some are found in the Neocomian and in the Chalk.

Hemicidaris intermedia, Fleming.

SYN. *Cidaris papillata*, var. Park. Org. Rem. pl. 1. fig. 6. vol. iii.

Cidaris intermedia, Fleming, Brit. Animals, p. 478.

Hemicidaris crenularis, Morris, Cat. Brit. Foss. p. 53; Strickland and Buckman, Geol. of Chelt.

Hemicidaris intermedia, Forbes, Brit. Org. Rem. Decade 3. pl. 4.

Test subglobose or subconical; ambulacral areæ narrow and slightly undulated, with a double row of small perforated tubercles on the margins, and ten larger tubercles at the basis of the areæ; interambulacral areæ occupied with six or seven pairs of primary tubercles which are raised on large closely-approximated prominent mammæ, with deeply crenulated summits; mouth large and decagonal, margins deeply notched; spines long, cylindrical, and striated longitudinally, with a tumid base; apical rosette not prominent.

Great Oolite specimens: height $\frac{2}{10}$ ths of an inch, transverse diameter 1 inch and $\frac{3}{10}$ ths. Coral Rag specimens: height 1 inch and $\frac{4}{10}$ ths, transverse diameter 1 inch and $\frac{6}{10}$ ths.

Description.—The test of this Urchin has sometimes a subglobose form; in other varieties the height exceeds the breadth, and it then presents a subconical outline. The summit is slightly depressed and the base is flat. The ambulacral areæ are narrow and gently undulated; at the base or lower third we observe five pairs of moderate-sized tubercles; at the upper two-thirds the tubercles become very small and are ranged on the margins of the areæ; both the large and small tubercles are mammillated and perforated. The pores are arranged in simple pairs, but at the enlarged space around the mouth additional pairs are introduced. The interambulacral areæ are nearly four times the width of the ambulacral, and-furnished with six or seven pairs of large primary deeply perforated tubercles. The mammillary eminences on which these tubercles are placed are largely developed and form prominent projecting cones, the bases of which touch those of the adjoining cones in the same range; an undulating line of small perforated granules separates the external border of the mammillary bases from the poriferous avenues, and a double row of similar granules forms a zigzag division down the centre of the areæ. The upper and lower boundaries of the areolæ of the mammæ are confluent, whilst their outer and inner boundaries are surrounded with the granules already described.

The apical rosette is moderate in size, being about one-fourth the diameter of the test; the madreporiform plate is larger than the pairs of ovarian plates; the ocular plates are heart-shaped, and the surface of the elements of this disc is studded with small granules.

The mouth is large, being half the diameter of the test; it has a decagonal form; and the margin is deeply notched.

The spines are of two kinds: the primary ones are long, cylindrical and tapering, and grow to double the length of the diameter of the test, some of them measuring $3\frac{1}{4}$ inches in length; they are delicately grooved in the longitudinal direction, and the base is provided with a raised crenulated band, situated between

two convex smooth bands ; another smaller crenulated band surrounds the rim of the socket which affords attachment to the ligaments articulating the spine with the tubercle. The secondary spines are small, needle-shaped and compressed, and striated longitudinally.

Affinities and differences.—This species approaches so near to *H. crenularis* that it was long regarded as Lamarck's species. The form and development of the spines of the two Urchins however prove them to be distinct ; this circumstance shows the necessity of caution in the identification of species of Echinidæ in the absence of any of the data upon which a correct opinion can alone be formed. *H. intermedia* resembles *H. icaunensis* in its general outline, but is distinguished from that species by its more prominent tubercles, in having the ambulacral aræ more undulated and having larger tubercles at the base. These characters likewise sufficiently distinguish it from *H. alpina* and *H. granulosa*.

Locality and stratigraphical range.—One of our specimens was obtained from the spoil of Salperton Tunnel from a bed belonging to the Great Oolite ; the other specimen was collected from the Bradford clay near Cirencester. We have never met with *H. intermedia* in the Inferior Oolite. This Urchin is very abundant in the Coral Rag of Calne, from whence most cabinets have been supplied. The varieties in the Great Oolite are more globular and depressed than those obtained from the Coral Rag.

History.—As it is uncertain whether we possess *H. crenularis* in our beds, it is probable that *H. intermedia* was figured and described by Martin Lister*. Our synonyms show the changes of name through which this species has passed. It has, however, been so accurately described by Prof. Forbes, and so admirably figured† in the 'Memoirs of the Geological Survey,' that we must refer to that work for further details of the species.

Hemicidaris icaunensis, Cotteau.

SYN. *Hemicidaris icaunensis*, Cotteau, Echin. Foss. t. 3. fig. 1-5. p. 56 ; Forbes, Geological Survey, Mem. Decade 3.

Test hemispherical, inflated and slightly depressed ; ambulacral aræ with two rows of small marginal tubercles, and with three or four pairs of larger tubercles at the base ; interambulacral aræ with two ranges of primary tubercles ; mouth large and decagonal ; margin deeply notched.

Height $\frac{9}{10}$ ths of an inch, transverse diameter 1 inch and $\frac{2}{10}$ ths.

Description.—This species is hemispherical and inflated at the

* Historia Animalium Angliæ, t. 7. fig. 21, 1678.

† British Organic Remains, Decade 3. pl. 4.

sides, and its transverse diameter is one-half more than its height. The interambulacral areæ are furnished with two rows of large primary tubercles; in each range there are from six to seven tubercles, which attain their greatest development at the equator of the test, and diminish in size near the anal and buccal openings. The mammillary eminences supporting the tubercles are large, prominent, and surrounded by areolæ. The tubercles are small and perforated; one row of granules separates the large tubercles from the poriferous avenues, and a double row occupies the middle of the areæ. The lateral boundaries of the areolæ are surrounded by a semicircle of granules, whilst the upper and lower boundaries of the same blend into each other.

The ambulacral areæ are narrow, slightly undulated, and furnished through nearly all their extent with a double row of small tubercles, which are not very apparent, but are larger on the sides than at the apex of the areæ; between the size of these and the three pairs of tubercles at the base a sensible difference exists. The mouth-opening is large, and is one-half the diameter of the test; it is of a decagonal form with the margin deeply notched. The apical disc is not preserved and the spines are unknown.

Affinities and differences.—The *Hemicidaris icaunensis* in its general form and characters closely resembles the *H. intermedia*; it is distinguished from the latter by having the primary tubercles of the interambulacral areæ less prominent, by the ambulacral areæ being less waved, and in having the basal tubercles much smaller. This character assimilates *H. icaunensis* to *H. Thurmanni*, but it is sufficiently distinguished from that Urchin by its greater height, less undulated ambulacra and the greater number of tubercular plates in the interambulacral areæ.

Locality and stratigraphical range.—This rare species was obtained by Mr. Lycett from the Great Oolite of Minchinhampton. M. Cotteau collected it in France from the superior beds of the Bathonian stage at Châtel-Censoir, and M. Rathier found it in the Forest marble of Châtel-Gérard, where it is likewise rare.

History.—This species was first figured and described by M. Cotteau*, and was provisionally identified by Prof. Forbes†; it is figured in plate A. fig. 9. of the 'Monograph of Great Oolite Fossils' to be published by the Palæontographical Society. The specimen that has come under our notice is so imperfect that we have followed M. Cotteau's description.

* Echinides Foss. du Département de l'Yonne, tab. iii. p. 56.

† Memoirs of the Geological Survey; Brit. Organic Remains, Decade 3. Description of plate 5.

Hemicidaris alpina, Agass. Pl. IV. fig. 3 a, b.

SYN. *Hemicidaris alpina*, Echin. Foss. Suisse, Agass. t. 18. fig. 19-22.

Test subglobose; ambulacral areæ undulated, prominent and convex, covered with small hemispherical granules closely set together; base of the areæ with four mammillated and perforated tubercles; apical disc large, convex and prominent.

Height nearly $\frac{1}{10}$ ths of an inch, transverse diameter $\frac{2}{10}$ ths of an inch.

Description.—The test of this beautiful species is subglobose; the ambulacral areæ are slightly undulated and of a medium size; they are prominent and convex, of an elongated conical form, and are thickly covered with small hemispherical granules without perforations or other sculpture; the marginal rows are larger and more regular. Between them are from four to six rows of smaller granules closely set together.

At the base of the areæ are four mammillated and perforated tubercles which are limited to this region. The pores are set obliquely in pairs with a smooth elevated granule between each pair, which forms a moniliform sinuous line running between the pores. The interambulacral areæ are of moderate breadth, with two rows of primary tubercles, five or six in each column. The mammillary eminences of the two central tubercles are large and prominent. Those towards the anal and oral poles are smaller; they are all crenulated at their summits; the tubercles are deeply perforated, and supported on a short stem, the hemispherical head of the tubercle not exceeding in diameter that of the stem; the areolæ around the mammæ are slightly channelled and nearly all confluent, those towards the anal pole have a circle of granules encircling the areolæ; the interareolar spaces are covered with small smooth granules similar in form and size to those occupying the ambulacral areæ. The apical disc is prominent, the ovarian plates are large, convex, and much granulated, and the ocular plates are of a proportionate size; the spines are unknown.

The mouth-opening is of moderate size, its margin being deeply notched and reflexed as in *H. intermedia*; the pores are disposed in simple pairs all the length of the poriferous avenues, but are arranged in double files around the border of the oral aperture in such a manner as to occupy the free space in the ambulacral areæ, resulting from the contraction of the interambulacral areæ in this region.

Affinities and differences.—Our specimen is smaller in size than the one figured by Agassiz from the Calcaire de Saanen. The ambulacra are more prominent and convex than those of the Swiss specimen; the rows of marginal granules are not so pro-

portionately large nor are the basal tubercles so numerous as those delineated in Agassiz's figure. We consider our Urchin, however, merely as a variety of the Swiss species, for which we propose the name var. *granularis*. This beautiful species is easily distinguished from its congeners by the structure of the ambulacral aræ, which are convex, prominent, and thickly covered with small close-set granulations unlike any other species of *Hemicidaris* yet known.

Locality and stratigraphical range.—This species was collected from the Bradford clay of Pickwick, Wilts; a valve of *Ter. digona* was attached to the test, and it is adherent to *Ter. concinna*. Plates of this Urchin have been found in the same stratum at the Tetbury Road Station of the Great Western Railway. Mr. Lowe of Chippenham has found it in the Forest marble of Wilts, but it is a rare species.

History.—First figured and described by Agassiz in the 'Description des Echinodermes Fossiles de la Suisse,' afterwards identified in the British Museum collection by Mr. S. P. Woodward, and recorded by Prof. Forbes in Decade 3. of his 'Memoirs of the Geological Survey,' and now described as a British species for the first time.

Hemicidaris granulosa, Wright. Pl. IV. fig. 4 a, b, c.

Test spheroidal, depressed; ambulacral aræ straight, with two rows of prominent defined granules, the three inferior pair only being perforated and raised upon crenulated mammillary eminences; interambulacral aræ with from two to three pairs of primary tubercles, the superior part of the aræ being occupied with warty granules; apical rosette formed of large petaloidal plates.

Height $\frac{7}{10}$ ths of an inch, transverse diameter 1 inch and $\frac{2}{10}$ ths.

Description.—This beautiful Urchin constitutes a well-marked species; the double row of prominent wart-like granules on the ambulacral aræ, which are neither perforated nor raised on eminences, serving as a good diagnostic character. The base of the area is enlarged to give space for the three pairs of crenulated and perforated tubercles found in this region in all the species of *Hemicidaris*. The upper part of the aræ is occupied with from 10–12 pairs of warty granules, which are smooth, deformed, and set regularly in rows alternating with each other; the intervening surface of the ambulacral plates being occupied with small ill-defined scattered granulations. The pores are disposed in slightly oblique pairs, with a raised eminence between them; at the wide basal region of the avenues they fall into triple oblique pairs.

The interambulacral areas are twice and a half the diameter of the ambulacral; in each column there are from six to seven plates, the three or four inferior of which support moderate-sized mammillary eminences with crenulated summits, from the centre of which a large prominent deeply perforate tubercle rises. The areolæ are smooth and gently inclined, and around their circumference fifteen small granules are set. The three superior plates are destitute of mammillary eminences, and in lieu thereof have clusters of granules on each plate similar to those occupying the ambulacral areas. There are from two to five such granules protruding from the upper surface of the test; they are arranged in pairs, or form triangular, quadrangular or pentagonal figures. The apical rosette is well developed; the *ovarial* plates are large and marked with a depression near their centre, and their internal borders are slightly raised. The *madreporiform* plate is larger than the pairs of plates, and its centre is occupied with a porous structure. The *ocular* plates are large and heart-shaped, with a depression down the centre of each plate. In the specimen before me the plates of the apical rosette are devoid of other sculpture.

The base is flat, the mouth large and decagonal, the opening being more than half the diameter of the test at its equator.

The spines are unknown.

Affinities and differences.—This Urchin differs from *H. intermedia* in the absence of tubercles from the upper part of the interambulacral areas, in the form and size of the ovarial and ocular plates, and in the form and structure of the granules covering the ambulacral areas. It is distinguished from *H. alpina* by the absence of the close-set granulations covering the convex ambulacra of that Urchin. It has some resemblance to *H. icaunensis*, but is distinguished from it by the small number of its primary tubercles, and the warty figures which take the place of the tubercles on the upper surface of the test.

Locality and stratigraphical range.—From the Inferior Oolite of Dundry. Imperfect specimens, probably belonging to this species, have been collected from the upper beds of Leckhampton.

Hemicidaris confluens, M'Coy.

SYN. *Hemicidaris confluens*, M'Coy, Annals of Nat. Hist. vol. ii. New Series, p. 411.

Test spheroidal, much-depressed; ambulacral areas slightly convex and nearly straight, with two alternate marginal rows of small microscopic mammillated and perforated tubercles, four pairs of larger tubercles at the base; intermediate surface covered with small close-set granulations; interambulacral areas with three pairs of large tubercles at the middle, four

small tubercles at the base, and six rudimentary tubercles at the apex of the arææ; mouth moderate and decagonal.

Height $\frac{2}{3}$ ths of an inch, transverse diameter $\frac{1}{3}$ ths of an inch.

Description.—The spheroidal test of this Urchin is much depressed at the anal pole and flattened at the base. The ambulacral arææ are nearly straight and of a tolerably uniform width throughout, and furnished with two rows of small, quite microscopic, but nevertheless mammillated and perforated tubercles, about fourteen in each row, disposed alternately on the margins of the arææ, and increasing slightly in size towards the basal angle. The base of the arææ has four pairs of larger tubercles as in the other species of this genus. The interambulacral arææ are nearly three times the width of the ambulacral, and furnished with two rows of tubercles from 9–10 in each row, the three pairs at the equator of the test alone attaining their full development; those at the base being of a secondary size, whilst those on the upper part of the arææ are disproportionately small and even rudimentary. The upper surface of the test is covered with small close-set granulations, in the midst of which the rudimentary tubercles rise at distant intervals apart. The mammillated eminences of the six large tubercles are surrounded by well-defined areolæ, which are confluent at their upper and lower margins; but down the centre of the arææ two or four rows of granules, and at the lateral borders thereof one or two rows of granules descend, which form lateral wreaths surrounding the side margins of the areolæ: these marginal granules are larger and more uniform in their arrangement than those occupying other parts of the surface of the test.

The mouth-opening, of a decagonal form, is one-half the diameter of the body, with deep marginal notches dividing its circumference into ten nearly equal lobes, those of the ambulacral arææ being the largest.

The apical disc is either absent or concealed in the specimens before me, and the spines are unknown.

Affinities and differences.—*H. confluens* resembles *H. Thurmanni*, Ag., in its depressed form and in the small number of the primary tubercles on the interambulacral arææ; it is distinguished from that species in the partial absence of the circle of granules which entirely surround the tubercles in *H. Thurmanni*, and in the rudimentary condition of those occupying the upper surface of the test. The ambulacral arææ are nearly straight in *H. confluens*, and much undulated in *H. Thurmanni*. This Urchin has many points of affinity with *Acrosalenia*, but our ignorance of the apical disc leaves a doubt in our mind whether it may not belong to that genus. Until specimens with the disc preserved are found, that doubt cannot be removed.

Locality and stratigraphical range.—This species was collected by Mr. Lycett from the planking beds of the Great Oolite at Minchinhampton, and we have received several specimens from the same stratum at Kiddington (Oxfordshire).

Hemicidaris pustulosa, Forbes.

Memoir of Palæontograph. Soc., Forbes, plate A. fig. 8, Great Oolite Fossils.

We have not seen *Hemicidaris pustulosa* figured by Professor Forbes in the above memoir; its nearest ally, it is stated, "is *Hemicidaris diademata*, Agass., which it resembles in the sudden diminution and very small size of the uppermost interambulacral tubercles, but differs in having the sutural granulated space of the interambulacral areas very wide*."

The SALENIANS†, Gray.

This group is composed of small Urchins resembling *Hemicidaris*; they are distinguished from that genus, however, by the number, structure, and mode of arrangement of the plates forming the apical disc, which is composed of five ovarial, five ocular, and a supra-anal plate. The ambulacral areas are narrow, carrying secondary tubercles like *Hemicidaris*. The pores are disposed in distinct poriferous avenues in single pairs. The interambulacral areas are wide, and their plates support primary tubercles raised on mammillary eminences. We divide the Selenians into two groups:—

In the first group the tubercles are not perforated; they form the genera *Salenia*, *Peltastes*, and *Goniophorus*, which are limited to the rocks of the Cretaceous period.

In the second group the tubercles are perforated, forming the genus *Acrosalenia*, the species of which are distributed throughout the Jurassic strata.

Genus ACROSALENIA, Agass.

Test small, more or less depressed; anal pole surrounded by a well-developed circular disc, composed of five ovarial and five ocular plates, with a central *supra-anal plate*, composed of one or more elements. The anal opening is situated at one side of the supra-anal plate, and is therefore eccentric. The ambulacral areas are narrow, and support a double row of from ten to twelve small perforated tubercles set on crenulated mammæ.

The interambulacral areas are nearly three times the width of the

* Memoirs of Geological Survey, Prof. Forbes, Decade 3.

† The group of Selenians is composed of five genera: *Salenia*, Gray; *Peltastes*, Agass.; *Goniophorus*, Agass.; *Acrosalenia*, Agass.; *Goniopygus*, Agass.

ambulacral arææ, and support two rows of from six to eight large perforated tubercles raised upon crenulated mammillary eminences; the base is flat, the mouth large, decagonal and notched, and the margin reflexed. The apices of the notches point to the centres of the columns of the interambulacral plates.

Acrosalenia hemicidaroides, Wright, n. s. Pl. IV. fig. 1 a, b, c, d.

Test hemispherical, considerably depressed; ambulacral arææ with two ranges of from fourteen to sixteen small perforated tubercles, gradually decreasing in size from the base to the apex; interambulacral arææ with two ranges of primary tubercles, eight in each range. The supra-anal plate is composed of several elements; the anus is situated before and to the left side; the surface of the ovarian, ocular, and supra-anal plates is studded with small granulations; primary spines long, tapering, smooth and slightly compressed; secondary spines small and needle-shaped; mouth large and decagonal; margin reflexed.

Height $\frac{7}{10}$ ths of an inch, transverse diameter 1 inch and $\frac{1}{10}$ th. One large specimen measures 1 inch and $\frac{3}{10}$ ths in diameter, but the proportional height cannot be ascertained, as its base is crushed.

Description.—Test spheroidal, depressed; ambulacral arææ slightly sinuous, nearly uniform in breadth, tapering towards both poles, and supporting two rows of secondary mammillated perforated tubercles, which are largest at the inferior third of the area, diminishing in size as they approach the mouth and the anus. The tubercles, from fourteen to sixteen in number in each row, are situated alternately on the margins of the area; a zigzag line of granulations, with lateral branches passing down the centre of the area, separates the tubercles from each other. The poriferous avenues consist of about forty-five pairs of pores set obliquely in a single file. The interambulacral arææ are three times the breadth of the ambulacral; each area is composed of two columns. There are eight plates in each column, and each plate supports a large smooth mammillated eminence surmounted by a tubercle, which occupies the greater part of the plate; it is of a conical form, and is encircled by a concave smooth areola. The summits of the mammæ are sculptured on their margins with eleven crenulations, in the centre of which a deeply perforated tubercle rises, with a rather depressed articular surface. In some specimens the areolæ of the mammæ are confluent, in others they are separated by a row of small granules. The external and internal margins of the plates are furnished with rows of small granulations, with still smaller granules here and there

interspersed; on the external side of each plate there are nine granulations, which, with those of the adjoining plates, form a sinuous granulated line which defines the internal boundary of the poriferous avenues. The internal row of granulations, with those of the opposite and adjoining plates, form a double granulated zigzag space, occupying the centre of the arææ, and forming an elevated ridge which serves to separate the two ranges of primary tubercles from each other.

The mouth is large and decagonal, and is one-half the diameter of the test. The margin is deeply notched with ten indentations. The divisions of the circumference are not equal, as the arch over the ambulacral is one-half greater than the arch over the interambulacral arææ.

The apical disc is greatly developed, occupying more than one-third the diameter of the test; it is of a pentagonal form, the left anterior angle being more developed than the right. The madreporiform plate is large, and divided into a posterior porous and an anterior non-porous segment. The posterior pair of ovarian plates are likewise large, the anterior pair are small and imperfectly developed; the left plate is rudimentary, in consequence of the anal opening being eccentric and situated before and towards the left side; the supra-anal plate is in general of a pentagonal form, and composed of from four to six elements united together and set round the posterior border of the anal opening. The ocular plates are triangular and well-developed; all the plates of the apical disc are studded with small granules. This species belongs to Agassiz's first division of the *SALENIANS* which have the sur-anal plate and the oviductal apparatus situated before the madreporiform plate. The primary spines (fig. 1 *d*) are long, tapering, and slightly compressed, so that a transverse section of one of them forms an ellipsis in the specimen before me. They are in length about twice the diameter of the test. The body of the spine is smooth throughout; the base is encircled with a prominent elevated ring of small oblong closely-set granulations; a smaller circle of larger crenulations surrounding the margin of the concave articulating surface. The secondary spines articulating with the tubercles of the ambulacral arææ resemble the primaries in miniature, some of them measuring $\frac{5}{16}$ ths of an inch in length.

The dental apparatus is well-developed. The teeth are strong, triangular, and slightly curved towards the point.

Affinities and differences.—*Acrosalenia hemicidaroides* is distinguished from its congeners by its size, the number and regularity of the primary tubercles, the compound structure of the supra-anal plate, and the granular surface of the apical disc. This Urchin so much resembles a *Hemicidaris* in the form of the test, the structure of the ambulacra and poriferous avenues, that it was not until we had obtained specimens with the apical disc

preserved that we were satisfied of its being an *Acrosalenia*, of which it certainly forms the finest species. The genera *Hemicidaris* and *Acrosalenia* have so many characters in common, which are almost always well-preserved, and so few that are *special*, and which are for the most part either broken or absent, that it is difficult to decide upon the genus unless the apical disc is more or less preserved; it is for this reason we conjecture that so few *Acrosalenia* have been hitherto catalogued from the Oolites, most of the species having been erroneously referred to other genera. The development of from four to six larger mammillated tubercles at the base of the ambulacral aræ is a good character for *Hemicidaris*. In *A. hemiciदारoides* the tubercles in this region are well developed, but are not so well defined as in *Hemicidaris*. When doubts exist, they can only be solved by the discovery of the apical disc with its supra-anal plate.

Locality and stratigraphical range.—I have collected this beautiful Urchin from the upper beds of the Inferior Oolite at Leckhampton, and the Rev. P. B. Brodie found it with its spines attached in the same zone at Selsley Hill. It is found in the planking beds of the Great Oolite at Minchinhampton, and in the Cornbrash near Chippenham. Several fine specimens with the spires attached to the test were obtained from the Forest marble near Malmsbury in Wilts, which are now in the British Museum and the Museum of Economic Geology, and several private cabinets. We have the same species from Kiddington, Oxfordshire, in slabs of Great Oolite. From these facts we infer that this large *Acrosalenian* had not only a considerable stratigraphical range, but likewise that the species was very abundant.

Acrosalenia Lycetti, Wright, n. s. Pl. IV. fig. 2 a, b, c, d.

Test hemispherical, depressed, circumference subpentagonal; ambulacral aræ prominent, having a double series of small tubercles; interambulacral aræ with two ranges of large tubercles; mammillary eminences of both aræ conical and projecting; tubercles of the interambulacral aræ disproportionately small.

Height half an inch, transverse diameter 1 inch.

Description.—This Urchin resembles *A. hemiciदारoides* in many of its characters, but presents others which justify its separation from that species. The ambulacral aræ are straight, prominent, and furnished with a double row of small well-developed tubercles, about twelve in each row; a zigzag line of small granules descends down the centre of the aræ, sending out lateral branches which inclose the areolæ of the tubercles for about two-thirds of their circumference, leaving the areolæ open to the poriferous avenues. The interambulacral aræ are nearly three

times the width of the ambulacral, and possess a double range of primary tubercles from seven to eight in each range. The mammillary eminences supporting them are very prominent, and are surrounded by an elliptical areola. The summits of the mammæ are sculptured with about ten crenulations. The tubercles are disproportionately small when compared with the development of the mammæ supporting them; the two ranges of tubercles are separated by four rows of granulations which form zigzag granular bands descending down the centre of the areæ; similar bands of granulations bound the external borders of the interambulacra, and separate the ranges of the principal tubercles from the poriferous avenues; the upper and lower borders of the areolæ are confluent, but the other parts of their circumference are surrounded by a wreath of granules. The mammillary eminences and tubercles are largest at the equator, gradually diminishing as they approach the oral and anal poles. The pores are large and disposed obliquely in simple pairs. The mouth-opening is large and decagonal, the marginal notches being of moderate depth. The apical disc is absent in all the specimens we have found; it is therefore impossible to state whether the anal opening was situated before or behind the single madreporiform plate.

Affinities and differences.—This species is distinguished from *A. hemicidaroides* in having the areolæ more excavated and elliptical. The granules occupying the intertubercular spaces are smaller and more numerous. The tubercles of the interambulacra are disproportionately small when compared with the development of their mammæ; the circumference has in general a subpentagonal outline, from the prominence of the ambulacral areæ, the double row of tubercles on which is more fully developed than in *A. hemicidaroides*. These differences between the tests of our two species although inconsiderable are nevertheless connected with others, which although not seen may be inferred, as the differences in the size and form of the primary and secondary spines belonging to the tubercles of both areæ leave no doubt on our mind that *A. Lycetti* is distinct from *A. hemicidaroides*, and we know of no other species among its congeners for which it could be mistaken. A granulated spine, and of which we give a figure (2 d), found frequently in the same beds with *A. Lycetti*, and probably belonging to this species, if proved to be such, would form an important specific character.

Locality and stratigraphical range.—We collected this Urchin from the lower ferruginous beds, Pea-grit, of Crickley Hill, and have found it in the same stratum at Leckhampton, Cleeve, and Brockhampton quarries. The specimens are in general much crushed, and the apical disc is always absent.

The two specimens which have preserved their form and served for the foregoing description were only obtained within the last few days ; all those previously collected having been too much injured to serve for minute observation.

I dedicate this species to my friend John Lycett, Esq., one of the learned authors of a monograph of the Mollusca from the Great Oolite.

Acrosalenia spinosa, Agassiz. Pl. V. fig. 3 *a, b, c, d*.

Acrosalenia spinosa, Agassiz, Echin. de la Suisse, 2nd part, t. 18. fig. 1-5. p. 39; Cotteau, Echin. Foss. du Département de l'Yonne, t. 3. fig. 6-11.

Test subpentagonal, depressed ; a double row of small tubercles occupies the ambulacra, and a double range of large mammillated tubercles the interambulacral areæ ; the ovarian disc is large, the madreporiform plate rudimentary, the anal opening behind the supra-anal plate ; mouth decagonal, margin deeply incised.

Height $\frac{3}{10}$ ths of an inch, transverse diameter $\frac{1}{2}$ ths of an inch.

Description.—The test of this beautiful little Urchin has a sub-pentagonal form arising from the convexity of the ambulacral areæ, which converge in straight lines from the base to the summit, and are furnished with two ranges of from ten to twelve very small tubercles, which, although microscopic, are nevertheless mammillated and perforated. The intertubercular spaces are covered with small granules which form circles around the tubercles. The pores are disposed obliquely in simple pairs, forming a single rectilinear file on each side of the areæ. The interambulacral areæ are twice the width of the ambulacral, and ornamented with a double range of primary tubercles, eight in each range. The two inferior tubercles are small, the two or three succeeding ones are very large, whilst those on the upper part of the test suddenly diminish in size and gradually become dwarfed as they approach the anal disc : they are all crenulated and perforated. The primary tubercles occupying the equator of the test are seated upon large prominent mammillary eminences, surrounded by deeply grooved elliptical areolæ, and encircled by a wreath of small granules. The intertubercular surface on the upper part of the test is studded with very fine granules. The apical rosette, formed of ovarian, ocular, and sur-anal plates, is admirably preserved in the specimens before us ; it is large and of a pentagonal form (fig. 3 *d*). The two anterior pairs of ovarian plates are nearly of the same size, the posterior pair being notched to form the basal angles of the triangular anal opening ; the sur-anal plate occupying the centre of the rosette is small, single and pentagonal ; the single or madreporiform plate is rudimentary, to make space for the apex of the

anal opening. By this arrangement it is evident that the anus is eccentric and situated behind the sur-anal plate; its opening is in a great measure formed by the imperfect development of the madreporiform plate, a condition the opposite to that existing in *A. hemicidaroides*, where the anus is situated in front of the sur-anal plate, and is excavated at the expense of the left anterior ovarian plate. The four ovarian and sur-anal plates are adorned with a delicate sculpture which occupies their centres; the ocular plates are small; the three anterior are inserted between the prominent angles of the ovarials, whilst the two posterior lying between the madreporiform plate and the posterior pair of ovarials form the lateral walls of the anal opening; all the plates are finely granulated.

The mouth is large, its circumference being divided into ten nearly equal lobes, and the margin is much reflexed.

Affinities and differences.—*Acrosalenia spinosa* is distinguished from its congeners by its subpentagonal form, the volume of the mammillary eminences of the primary tubercles at its equator, and the sudden smallness of those occupying the upper part of the test, the position of the anal opening behind the sur-anal plate, and the rudimentary condition of the madreporiform plate.

Locality and stratigraphical range.—I collected this Urchin from the yellow clay resting on the Stonesfield slate at Sevenhampton with *Anabacia orbulites*, *Pecten vagans*, *Ostrea acuminata*, and other Great Oolite shells. Likewise from the Cornbrash near Chippenham, Wilts, where it is very abundant. The specimens from both localities are as perfect as recent *Echini*.

Many of the Cornbrash specimens are attached to *Avicula echinata*. In Switzerland *A. spinosa* was collected from marls containing *Ostrea acuminata* in the Canton of Soleure. It is found in great abundance in France in the Great Oolite of Caen, and has been collected by M. Cotteau from the upper beds of the Bathonian stage in the environs of Châtel-Censoir.

History.—This species was figured and described for the first time by M. Agassiz in his 'Echinoderm. Fossiles de la Suisse,' and entered in his 'Catalogue raisonné des Echinides.' It has been figured and described by M. Cotteau from specimens obtained in the department of l'Yonne. It is catalogued by Mr. McCoy as a Minchinhampton species from the Great Oolite, and is now described from British specimens for the first time.

Genus GONIOPYGUS, Agassiz.

Test circular, subconical; apical disc very solid with an angular circumference, composed of ten plates; sur-anal plate absent; mouth large; tubercles imperforate without crenulations at their base; pores disposed in simple pairs throughout.

Goniopygus (?) *perforatus*, Wright, n. s. Pl. VI. fig. 5 a, b.

Test spheroidal, depressed; ambulacral arææ with two rows of small tubercles; interambulacral arææ with two rows of nearly equal-sized primary tubercles, each surrounded by a circle of granules; tubercles perforated.

Height $\frac{5}{10}$ ths of an inch, transverse diameter $\frac{6}{10}$ ths of an inch.

Description.—The ambulacral arææ of this little anomalous Urchin carry small marginal tubercles increasing in size towards the base of the arææ, and having a few granules interspersed between them. The interambulacral arææ are about twice and a half the width of the ambulacral, and furnished with two rows of tubercles from seven to eight in each row. The tubercles are raised on mammillated eminences which are destitute of crenulations; the summit of the tubercles is slightly perforated, they detach themselves in a well-defined manner from the surface of the test and are very uniform in size, and each mamma is encircled by a distinct wreath of small granules. There are a few other granules studding the plates besides those forming the boundary circles of the areolæ. The apical disc is absent; the mouth is large and deeply notched.

Affinities and differences.—I have placed this Urchin provisionally in the genus *Goniopygus*, as it comes nearer to the characters of that form than any other. Agassiz states in his Catalogue that the tubercles are imperforate, but this character is not alluded to in his 'Echin. Foss.' The absence of crenulations from the mammæ, the nearly uniform size of the tubercles, the distinctness with which they stand out from the test, and a fragment of the angular apical disc *in situ*, seem to justify the supposition of its being *Goniopygus*; but the perforations in the tubercles make the exception, and suggest the query whether the absence of perforations is a generic or only a sectional character. The specimens before me, the only three yet found, are so imperfect, that I write with much reserve regarding them; they may perhaps prove to be the young tests of *Pedina*, in which we have observed that the pores change from simple pairs to triple oblique pairs with age, and the crenulations of the mammæ can scarcely be seen.

Locality.—I collected these Urchins from the Pea-grit of Crickley Hill with *Acrosalenia Lycetti* and small Bryozoan poly-pifera.

The ECHINIDÆ*

Have a thin test, and are distinguished from the Cidaridæ and

* The group of *Echinidæ* includes twenty-three genera: *Astropyga*, Gray; *Diadema*, Gray; *Hemidiadema*, Agass.; *Cyphosoma*, Agass.; *Echinocardis*,

Salenians by having numerous nearly equal-sized tubercles upon the ambulacral and interambulacral arææ. The pores are differently arranged in the avenues in the different genera; the apical disc consists of five ovarial and five ocular plates.

Genus DIADEMA, Gray.

Test thin, of a circular or pentagonal form, more or less depressed, supporting perforated tubercles raised on mammillary eminences with slightly crenulated summits. The ambulacral arææ are wide, straight, and well developed; each area has two rows of primary tubercles nearly as large as those occupying the interambulacral arææ. The pores are set in pairs, uniformly superimposed on each other, with one or two exceptions, where they fall into double files. The interambulacral arææ have two rows of primary tubercles, and sometimes ranges of secondary tubercles placed external to them. The mouth is large and decagonal, with shallow marginal notches. The five ovarial plates have an elongated hexagonal form; the madreporiform is larger than the pairs of plates; the five ocular plates are small and triangular, and are lodged at the summits of the ambulacra between the re-entrant angles formed by the ovarial plates. The spines are long, slender, and subulate, and of a very uniform size throughout.

Diadema depressum, Agassiz. Pl. V. fig. 2 a, b, c, d.

SYN. *Diadema depressum*, Agassiz and Desor, Catalogue raisonné des Echinides, Ann. des Sciences Nat. 1846; Cotteau, Etudes sur Echinides Fossiles, p. 43. t. 2.

Test pentagonal, depressed; ambulacral arææ convex and prominent; interambulacral arææ flattened; two rows of nearly equal-sized primary tubercles in both arææ; secondary tubercles absent or rudimentary; mouth large and slightly decagonal.

Height $\frac{5}{10}$ ths of an inch, breadth 1 inch and $\frac{1}{10}$ th.

Description.—The ambulacral arææ of this Urchin are rather more than one-half the breadth of the interambulacral arææ, and have from ten to twelve pairs of well-developed primary tubercles separated by a zigzag line of small granulations. The interambulacral arææ are nearly of a uniform breadth throughout; there are about ten pairs of tubercles in each area; in consequence of

Desmoulins; *Echinopsis*, Agass.; *Arbacia*, Gray; *Eucosmus*, Agass.; *Cælopleurus*, Agass.; *Codiopsis*, Agass.; *Mespilia*, Desor; *Microcyphus*, Agass.; *Salmacis*, Agass.; *Temnopleurus*, Agass.; *Glypticus*, Agass.; *Polycyphus*, Agass.; *Amblypneustes*, Agass.; *Boletia*, Desor; *Tripneustes*, Agass.; *Holopneustes*, Agass.; *Echinus*, Linn.; *Pedina*, Agass.; *Heliocidaris*, Desmoulins.

these segments of the test being double the width of the ambulacral, the tubercles stand more apart. The tubercles of both areæ are nearly uniform in size, they have a smooth base with a finely crenulated summit, and are perforated; there are no secondary tubercles, but the intertubercular spaces are covered with small granulations, which are closely set together on the surface of the plates; three or four of these at the base of the areæ are perforated. The mammillary eminences of both areæ are surrounded by smooth areolæ, which are nearly all confluent. The ambulacral areæ become rapidly contracted towards the vertex, whilst the interambulacral areæ maintain their breadth, so that the space between the rows of primary tubercles is very uniform in width throughout. The intertubercular spaces, with the exception of the internal border of the four superior interambulacral plates, are covered with small close-set granulations of different sizes, which form semicircles around the areolæ, and zig-zag lines down the centres of the areæ. The pores consist of thirty-six pair in each avenue superimposed in a single file; in the wide space of the avenues around the mouth they form double or triple rows. The mouth is large and decagonal; the notches are slight, and the borders are reflexed at the angles; the apical disc is unknown; the spines are small, subulate, and delicately striated longitudinally (fig. 2 d).

Affinities and differences.—This Urchin resembles *D. æquale*, Agass., but differs from it in the absence of secondary tubercles in the interambulacral areæ: by its pentagonal form it resembles *D. subangulare*, but is distinguished from that species in having the pores arranged in a single file, whereas in *D. subangulare*, from the equator to the apical disc, the pores fall into double files. The tubercles are likewise smaller and more deeply perforated; it belongs moreover to a lower zone of the Oolitic group, *D. subangulare* being a characteristic Urchin of the Coral Rag of Wilts and the "Terrain à chailles" of Switzerland and Germany*. Like *D. subangulare*, *D. depressum* possesses a pentagonal form, a peculiarity depending on the prominence of the ambulacral areæ, and common to several species of this genus.

Locality and stratigraphical range.—This Urchin is common in the lower ferruginous beds of the Inferior Oolite, the Pea-grit of Crickley, Leckhampton and Dundry Hills; I have collected it from the Great Oolite at Minchinhampton and from the Bradford clay at Tetbury road station; the latter were extremely small. The specimens are in general much crushed; the anal disc is always broken, and the spines are sometimes adherent to the test. It has been collected by M. D'Orbigny in the Inferior oolite of

* Goldfuss, Petrefacta Germaniæ; and Agassiz, Echinodermes Fossiles de la Suisse.

Saint Honorine Ranville, where it is abundant. It has been obtained by M. Cotteau from the ferruginous oolite, from Tour-du-Pré, near Avallon, Département de l'Yonne, which bed lies upon the Calcaire à entroques, the true equivalent of the Dundry, Cotteswold and Dorsetshire beds of the Inferior Oolite.

History.—The *D. depressum* was first mentioned in the 'Catalogue raisonné des Echinides' by Agassiz and Desor, but was neither figured nor described by them. This however has been done by M. Cotteau in his 'Études sur les Echinides Fossiles,' and is now figured and described from the English Oolites for the first time. In both countries it appears to characterize beds belonging to the same geological horizon.

Diadema subangulare, Agass.

SYN. *Cidarites subangularis*, Goldfuss, Petref. t. 40. f. 3; Roemer, Verstein. t. 1. fig. 20.

Diadema subangulare, Agassiz, Echin. Foss. t. 17. fig. 21–25. p. 19.

Test subpentagonal, depressed; interambulacral aræ with primary and secondary tubercles; upper part of the poriferous avenues with a double series of pores.

Height $\frac{2}{3}$ ths of an inch, transverse diameter 1 inch and $\frac{2}{3}$ ths.

Description.—The test of this Urchin has a depressed and pentagonal form arising from the prominence and development of the ambulacral aræ, which are narrow and contracted above and furnished with ten pairs of primary tubercles. The interambulacral aræ are nearly twice as wide as the ambulacral, and are adorned with two rows of primary tubercles from ten to eleven in each row, and two rows of secondary tubercles arranged on the sides of the primaries, but irregular both as regards their number and size. Secondary tubercles are absent in the ambulacral aræ. The tubercles of both aræ are proportionally large and raised upon inconsiderable mammillary eminences with delicately crenulated summits; the mammæ are surrounded by elliptical areolæ, and round two-thirds of their circumference small granules are disposed in circles; although the tubercles are large and spherical, the perforations are small and of inconsiderable depth. Down the centres of both aræ numerous small granulations occupy the intertubercular surface of the plates, and similar granular bands descend down the external margins of the interambulacral aræ; but the distinctive character of this Urchin resides in the structure of the poriferous avenues, which, instead of forming, as in other *Diademata*, a single row of pores from the base to the apex, from the equator to the apical disc they form double rows of pores disposed in oblique lines.

The mouth is large and decagonal, but the marginal notches

are not deep. None of the specimens that we have seen possess the apical disc, but the vacant space left by the absence of the ovarian and ocular plates proves that this part of the test was well developed.

Affinities and differences.—In its pentagonal form it is allied to *D. depressum*, but its secondary tubercles and double file of pores form a good diagnosis between *D. subangulare* and other species of the same genus.

Locality and stratigraphical range.—We know this species only from the Coral Rag of Wilts and Oxford; in Germany it is found in the same stages at Thurnau and Muggendorf; and in Switzerland it is obtained from the "Terrain à chailles" of the valley of the Birse, of Blochmont and of Weissenstein.

History.—First figured by Goldfuss, afterwards more accurately described and figured in detail by M. Agassiz, and now described as a British species for the first time; the specimens previously catalogued under this name having been *D. depressum* and not *D. subangulare*.

Diadema pseudo-diadema, Agass. Pl. V. fig. 1 *a, b, c*.

SYN. *Cidarites pseudo-diadema*, Lamarck, Syst. Anim. sans Vert. tom. iii. p. 385.

Diadema Lamarckii, Desmoulins, Tabl. Synopt. p. 316. No. 18.

Diadema pseudo-diadema, Agassiz, Echin. Foss. t. 17. fig. 49–53.

Test hemispherical, depressed; interambulacral arææ with primary and secondary tubercles; ambulacral arææ with primary tubercles and a few scattered rudimentary ones. Mouth large and decagonal; margin deeply notched; apical disc large; spines long and needle-shaped.

Height 1 inch and $\frac{5}{10}$ ths, transverse diameter 2 inches and $\frac{4}{10}$ ths.

Description.—This fine species has a hemispherical form, much depressed at the anal pole and flattened at the base. The ambulacral arææ are straight and well developed, and furnished with two rows of primary tubercles from 18–20 in each row; between these a zigzag line of small secondary tubercles extends two-thirds up the arææ; the poriferous avenues are not well defined; the pores are disposed in pairs; between each pair of holes there are elevated smooth tubercles forming a range of small bead-like bodies which define the limits of the arææ; at the base the pores fall into double and triple files.

The interambulacral arææ are more than twice the width of the ambulacral, and are furnished with two rows of large primary crenulated and perforated tubercles, and several rows of secondary tubercles likewise crenulated and perforated; down the

centre of the arææ two rows of secondary tubercles are arranged which separate the principal ranges from each other, and like rows of secondary tubercles separate the principal tubercles from the ambulacral arææ. These secondary tubercles are very irregular as to size and arrangement, and are in general best developed at the base and equator of the test; besides the primary and secondary tubercles, the surface is studded with small granulations. The mouth-opening is large and decagonal, and its margin is divided by deep notches. The lobes which correspond to the ambulacral arææ are twice as large as those corresponding to the interambulacral arææ. The apical disc is broken in the specimen before me. According to Agassiz the oviductal apparatus is generally very apparent. The ovarian plates are large and pentagonal; their summit forms a prominent angle which advances into the interambulacral arææ. The madreporiform plate is larger than the pairs of plates, and like them is perforated and finely granulated. The ocular plates are very small and inserted between the angles of the ovarials and dovetailed with the apex of the ambulacra. The anal opening is large and of a circular form. The spines are long, needle-shaped, and finely striated longitudinally.

Affinities and differences.—The size of this species, the arrangement of the secondary tubercles, and the structure of the poriferous avenues form a group of characters by which it is readily distinguished from its congeners.

Locality and stratigraphical range.—The specimen before me was obtained from the Coral Rag of Wiltshire or Oxfordshire; it is found in the Corallian stage of Besançon, canton of Soleure, in Switzerland, and in the Coral Rag of Angoulin, near Rochelle, in France.

History.—Figured and accurately described for the first time by M. Agassiz in his 'Echin. Foss.,' and now first figured and registered as a British fossil.

Genus PEDINA, Agassiz.

Test thin, circular and depressed; primary tubercles very small, but still perforated and crenulated like those of *Diadema*. Pores arranged in triple oblique pairs as in the genus *Echinus*. Mouth small, slightly decagonal; margin not much notched. The ovarian disc not prominent; the surface of the test comparatively smooth when compared with the other genera of the *Echinidæ*. The ambulacral arææ have two ranges of tubercles, and the interambulacral arææ have two ranges of primary, and one or more rows, more or less complete, of secondary tubercles, situated at the external and internal sides of the primaries. This

genus is extinct, and the species are found in the Oolitic and Cretaceous rocks.

Pedina rotata, Agassiz.

SYN. *Pedina rotata*, Agassiz, Echin. Foss. de la Suisse, pl. 15. fig. 4-6. p. 36.

Test hemispherical, depressed; ambulacral arææ with two marginal rows of small tubercles; interambulacral arææ with two ranges of primary tubercles and a few secondary tubercles; mouth small; margin slightly notched and divided into ten nearly equal-sized lobes.

Height $\frac{3}{10}$ ths of an inch, transverse diameter 1 inch and $\frac{4}{10}$ ths.

Description.—The test of this Urchin is circular; in some specimens a fullness of the ambulacral arææ gives it a slightly-subpentagonal outline, and it is depressed at both poles. The ambulacral arææ have two rows of small tubercles disposed on the external border of the arææ, between which small granules are arranged with less regularity. The interambulacral arææ are twice and a half the width of the ambulacral, and furnished with a double range of primary tubercles extending from the mouth to the ovarian plates; two ranges of secondary tubercles, not very regular however in their arrangement, extend from the mouth to near the middle of the arææ. The tubercles of both classes are very small in size, but perforated and crenulated; on the surface of the test a number of small microscopic granules cluster together, and form circles around the areolæ of the small mammillated eminences. The poriferous avenues are narrow, in which the holes are closely set in triple oblique pairs; in the three specimens before me the apical disc is either absent or concealed by the oolitic matrix. The mouth is small and decagonal. The margin is slightly notched, and divided into ten nearly equal-sized lobes; no reflection of the test is observed at the angles of the notches. The spines are unknown.

Affinities and differences.—This species is distinguished from *P. sublaevis* by the rudimentary development of the secondary tubercles in the interambulacral arææ, which can only be said to exist at the internal side of the primaries, between the mouth and the equator; in the rest of the arææ they degenerate into granules. The other characters of the Urchin agree so well with Agassiz's very incomplete description, that we have not hesitated to identify it with the Swiss species. Our specimens are all much worn, and we know nothing of the apical disc.

Locality and stratigraphical range.—This Urchin was collected from the upper beds of the Inferior Oolite at Shurdington Hill, along with *Discoidea depressa* and *Chlypeus sinuatus*.

History.—First described and figured by Agassiz in his 'Echi-

nodermes Fossiles.' Mr. M'Coy catalogues this species from the Great Oolite of Minchinhampton, but we know of no specimens from that locality; all the examples, five in number, examined by us, have been obtained from the upper beds of the Inferior Oolite.

Genus ECHINUS, Linnæus.

Test more or less globular. Ambulacra in general about half the width of the interambulacra; primary tubercles of nearly the same size in both aræ, and forming vertical ranges more or less numerous in the different species, but neither having perforated summits nor crenulations at their base; the poriferous avenues are well-developed; the pores are numerous, and disposed in transverse ranges in arched or triple oblique pairs; the mouth is large, of a circular or pentagonal form, and more or less divided at the margin by notches into ten lobes. The apical disc is composed of four nearly equal-sized ovarian plates, and a single larger madreporiform plate, and between the ovarian the five ocular plates are lodged. The masticatory organs or lantern are formed as in the genus *Cidaris*; but the pyramids are excavated in their superior part, and the two branches are united by an arch at the summit. The teeth are tricarinated.

Echinus perlatus, Desmarest. Pl. VI. fig. 1 *a, b, c, d.*

SYN. *Echinus perlatus*, Desm. Dict. Sc. Nat. t. xxxvii. p. 100.

Echinus lineatus, Goldf. Petrefact. Germaniæ, t. 40. fig. 11.

Echinus germinans, Phillips, Geology of Yorkshire, pl. 3. fig. 15.

Echinus perlatus, Agassiz, Echin. Foss. de la Suisse, t. 22. fig. 13-15.

Echinus diademata, M'Coy, Ann. Nat. Hist. vol. ii. S. 2. p. 410.

Echinus multigranularis, Cotteau, Echinides Foss. de l'Yonne, p. 61. tab. 7. fig. 6-8.

Test hemispherico-conoidal with a pentagonal circumference; ambulacral aræ with two ranges of primary tubercles; interambulacral aræ furnished with two complete ranges of primary tubercles and six incomplete ranges of secondary tubercles, and a median depression in the centre of the aræ; apical disc small; anus eccentrical.

Height $1\frac{1}{2}$ inch, transverse diameter 2 inches.

Description.—The ambulacral are about one-half the breadth of the interambulacral aræ, and are very uniform in width throughout; they are prominent and convex, giving the circumference of the test of this beautiful Urchin a pentagonal form. The ambulacral columns have two rows of primary tubercles, about thirty in each row, placed on the poriferous borders of the plates, and from four to six tubercles between these rows at the base and angle of the test. The interambu-

lacræ are slightly convex, and taper very uniformly from the base to the summit. The lower half of the areæ is occupied by eight rows of primary tubercles, four in each column; at the base and for a short distance up the sides of the test, these tubercles are of a uniform size, but beyond this two rows only maintain their development, and numbering twenty-four pairs of primary tubercles in each area; the two external rows and the single internal row of tubercles are arrested in their development, and therefore become of a secondary size. The tubercles of both areæ are surrounded by a smooth areola encircled by a groove, on the external margin of which a wreath of small granules is disposed, reminding us of the granular zone surrounding the primary tubercles in the genus *Cidaris*. The intertubercular spaces of the areæ are filled up with small granules. The interambulacral areæ are separated along the median line by a somewhat depressed furrow, which is most conspicuous between the equator and the anal pole. This furrow arises from the convexity of the new-formed plates, and becomes less evident when the plates attain a greater width; this depression is likewise destitute of granulations, and affords a good specific character for this Urchin. The poriferous avenues are of uniform width on the sides of the test; they become slightly contracted at the basal angle, and expand from that point to the margin of the mouth-opening. The avenues have three pairs of holes disposed obliquely throughout, but increased to four or five pairs to fill up the increased spaces of the avenues in the vicinity of the mouth. The ovarial and ocular plates are in general preserved. The anal opening is always eccentric, which gives the summit of the test an irregular form; the opening is placed forward, so that the madreporiform plate occupies nearly the centre of the anal polar axis. The pairs of ovarial and ocular plates are small and imperfectly developed.

The base is concave, and in this region all the primary tubercles of the interambulacral areæ attain their full development. The mouth-opening is large and decagonal, occupying nearly one-half the diameter of the base; the circumference is deeply notched with ten indentations which extend into the interambulacral areæ, and have their borders reflexed.

The spines are small, delicate, and subulate, but are very seldom found in connection with the test.

Affinities and differences.—We have, through the courtesy of Mr. S. P. Woodward, compared our Urchins with the typical specimens of *E. perlatus* in the Brit. Mus., and through the kindness of Professor Forbes with a specimen of *E. germinans*, sent by Mr. Phillips from Yorkshire; from this examination it is certain that the Gloucestershire and Yorkshire *Echini* are

the same species, and that the difference between them and the foreign *E. perlatus* from the evidence afforded by the test alone amounts at most to a more granular variety. We may consider therefore *E. perlatus*, var. *germinans*, as characteristic of the inferior stages, and *E. perlatus* of the upper stages of the Oolitic group. *E. diademata* of M'Coy agrees so nearly with our specimens of the young of this species that we think them the same.

Stratigraphical range and localities.—This Urchin is found in good preservation in the inferior ferruginous beds of the Pea-grit at Leckhampton, Cleeve, and Crickley Hills. Our best specimens were obtained from the latter locality; it is found in the shelly freestone of the above hills, and in the Inferior Oolite of Stroud, Nailsworth, Minchinhampton and Dundry; its convex prominent ambulacral columns, and the median furrow down the centre of the interambulacral areas, serving to determine the species even when its other characters are effaced. On the continent *E. perlatus* is considered a characteristic Urchin of the "Terrain à chailles," and was long ago described by Desmarest. The specimens from the Inferior Oolite are more granular than those obtained from the upper stages of the Oolitic series, but in other respects the specific characters are identical.

History.—*Echinus perlatus*, figured and described by Desmarest and Goldfuss, has been long known to characterize the upper Oolitic beds of the continent. We have no doubt that Mr. Phillips's *E. germinans* is at most only a variety of this species found in the Inferior Oolites of England. Mr. M'Coy's description of *E. dimidiata* corresponds so closely with young specimens of this species, a series of which now lies before us, that we cannot doubt their identity.

Echinus serialis, Agass. Pl. VI. fig. 2 a, b, c, d.

SYN. *Echinus serialis*, Agassiz, Echin. Foss. de la Suisse, t. 22. fig. 10-12.

Test hemispherical, depressed, circumference slightly pentagonal; ambulacral areas with two rows of marginal tubercles; interambulacral areas with two ranges of tubercles in the centre of the columns; base concave, mouth moderate-sized, decagonal, and slightly notched; apical disc small; anus slightly eccentric.

Height 1 inch, transverse diameter 1 inch and $\frac{7}{10}$ ths.

Description.—This *Echinus* resembles a *Diadema* in having two ranges of tubercles very nearly the same size on both areas; the ambulacral are rather more than one-third the width of the interambulacral areas, and are furnished with two rows of small tubercles, each alternate plate supporting a tubercle on its periferous margin; the interambulacral areas are wide, and have in

like manner two ranges of small tubercles, about twenty in each range, occupying the centre of the plates; the tubercles are raised on inconsiderable mammillary eminences surrounded by smooth areolæ, and encircled by a zone of small granules; the intertubercular spaces of both areæ are covered with similar small granulations; there are a few irregular secondary tubercles about the base, but none on the sides of the interambulacral or ambulacral areæ; the poriferous avenues are narrow, and occupied by numerous close-set pores arranged in triple oblique pairs; the basal angle is obtuse, and the base concave; in this region the tubercles are largest, and a few additional ones are introduced at each side of the central range; the mouth-opening is moderate, being $\frac{7}{10}$ ths of an inch in diameter; it is nearly of a circular form, the marginal notches being of inconsiderable depth; the ovarial and ocular plates are small and preserved; in some of the smaller specimens the madreporiform plate is larger than the pairs of ovarials; the anus is situated before the single plate, and to the right side, and is therefore slightly eccentric. The spines are unknown.

Affinities and differences.—The comparative smoothness of the test, and the absence of secondary tubercles, with the smallness of the marginal notches in the mouth-opening, form diagnostic characters by which we distinguish *E. serialis* from *E. perlatus*; the median depression between the two columns of interambulacra is likewise absent in this species.

Locality and stratigraphical range.—This species has been collected from the Inferior Oolite at Shurdington and Dundry Hills; the specimen from the latter locality is the one which has served for our description, the parts of the test which are broken being fortunately present in the smaller Urchin from the former locality; the Swiss specimens were found in the "Terrain à chailles" at Fringeli (Canton of Soleure), where it is very rare.

History.—First found by M. Gressly and figured and described by M. Agassiz in his 'Echin. Fossiles'; we are not aware of its having been noticed before as a British species.

Echinus granularis (Wright), n. s.

Test depressed, pentagonal; ambulacral areæ with two rows of tubercles; interambulacra with eight rows of tubercles, at the base and lower third of the areæ diminishing in size and number from six to four rows towards the apex; mouth large with marginal indentations; anus central; ovarial and ocular plates small.

Height $\frac{7}{10}$ ths of an inch, transverse diameter $1\frac{1}{2}$ inch.

Description.—This Urchin is distinguished from the foregoing species by its depressed poles and pentagonal form, arising from

the prominence of the ambulacral arææ, which are not quite one-half the width of the interambulacral, and have two rows of tubercles throughout, and an additional row of from six to eight arranged between the marginal rows at the widest part of the arææ near the basal angle; the interambulacral arææ are wide and covered with tubercles; at the basal angle and lower third of the arææ we observe eight rows of tubercles, but at the upper part of the sides and near the apex there are only six rows: the specimen before us being much defaced about the apices of the arææ, this part of the test cannot be accurately described. The poriferous avenues are occupied with close-set pairs of pores arranged in triple oblique rows; the basal angle is obtuse, and the base is flat; the mouth is large and indented at the circumference; the ovarian and ocular plates are small, and the anus is central.

Affinities and differences.—The depressed test, pentagonal form, central anus and granular surface serve to distinguish this species from *E. perlatus*, which it much resembles. The same characters form a clear diagnosis between it and *E. serialis*, the number and smallness of the tubercles giving the upper surface of the test a rugous or granular appearance.

Locality and stratigraphical range.—This Urchin was obtained from the upper ragstone of Leckhampton Hill (Inferior Oolite), where it is rare; we have only seen three specimens of the species.

Genus ARBACIA, Gray.

Small Urchins of a subspherical form, having the test covered with numerous small smooth-based imperforate tubercles, forming numerous rows on the ambulacral and interambulacral arææ; the pores arranged in rather deep avenues in single pairs; base concave; mouth large, margin with ten inconsiderable notches; apical disc narrow, prominent, and ring-shaped.

Arbacia Forbesii, Wright, n. s. Pl. VI. fig. 4 a, b, c.

Test hemispherical; ambulacral arææ narrow, with four rows of small tubercles; interambulacral arææ wide, divided by deep median depressed lines, and covered with from twenty to thirty rows of small nearly equal-sized tubercles.

Height $\frac{2}{10}$ ths of an inch, transverse diameter $\frac{1}{4}\frac{2}{10}$ ths of an inch.

Description.—The test of this beautiful little Urchin is divided into fifteen unequal lobes; five of these are narrow and form the ambulacral, and ten are wider, forming the divided interambulacral arææ, which present an unusual appearance, having a median furrow descending down the centre of the arææ and dividing them into two equal convex conival lobes; the surface of the arææ is

thickly studded with small smooth tubercles ; at the widest part there are from twenty-five to thirty rows ; the number of these diminish at the apex and base, the basal tubercles are however larger than the others ; the ambulacral aræ are narrow and of a nearly uniform width ; they are furnished with four rows of small tubercles similar to those occupying the interambulacral aræ ; they are in fact so closely set together that the plates are invisible, so that the test presents only a uniform granulated surface ; the avenues are straight, narrow, but well defined ; the pores are closely arranged in simple pairs ; the base is concave and the tubercles in this region are larger ; the mouth presents almost a pentagonal form in consequence of the wide straight arch made by the margin over the ambulacra and the small angles which the shallow notches make in the interambulacra ; the apical disc is narrow and prominent ; the madreporiform is larger than the pairs of ovarial plates, and the oculars are small, but apparently soldered into the angles formed by the ovarials.

Affinities and differences.—The greater number and the diminished size of the tubercles, with the deep median furrow down the centre of the interambulacral aræ, serve to distinguish *A. Forbesii* from *A. nodulosa* : as they are the only two forms of this genus hitherto found in our Oolites, these characters form a good diagnosis.

Locality and stratigraphical range.—This Arbacia was collected from the upper beds of the Inferior Oolite near Dundry, and we only know it from that locality. I have dedicated this species to Prof. Edward Forbes, to whose genius, talents, and learning natural history is so largely indebted.

Arbacia nodulosa, Wright. Pl. VI. fig. 3 a, b.

SYN. *Echinus nodulosus*, Goldfuss, Petr. Germaniæ, t. 40. fig. 16. p. 125.

Test hemispherical, with a subpentagonal circumference ; ambulacral aræ prominent and bounded by deep poriferous avenues ; interambulacral aræ divided by a slight median depression ; tubercles nearly equal-sized in both aræ, and arranged in longitudinal rows.

Height $\frac{7}{10}$ ths of an inch, transverse diameter $\frac{1}{2}$ ths of an inch.

Description.—This nodulated Urchin is hemispherical and has a subpentagonal form from the development of the ambulacral aræ, which are very prominent, especially at the basal angle ; they are furnished with three rows of smooth prominent spherical tubercles set at short distances apart, the central row being absent at the base and apex of the aræ ; the interambulacral aræ are twice the width of the ambulacral, and are occupied at their widest parts

with about ten rows of tubercles, about the same size as those of the ambulacral, and like them set distinct from each other, which gives the surface of the test a nodulated air; a slight furrow passes down the centre of the interambulacral areæ, dividing them into two parts; the rows of tubercles diminish in number at the apex and base of the areæ, they are larger and more fully developed, however, in the latter region; the apical disc is small, ring-formed, and prominent; the poriferous avenues are deep and strongly defined, the pores are arranged in simple pairs above, but they form double ranges which fill up the wide space at the basis of the areæ; the base is concave, the mouth is large and pentagonal like the former species, the notches are closely approximated at the bases of the interambulacra, and the marginal arch over the ambulacra is straight and wide; the tubercles disposed at the bases of both areæ are larger and more fully developed than those occupying the sides.

Affinities and differences.—The size of the tubercles and their diminished numbers when compared with *A. Forbesii* serve as a sufficient diagnosis whereby *A. nodulosa* may be distinguished from the former Urchin; the slight median furrow down the centre of the interambulacral areæ is very different from the deep line separating the areæ in *A. Forbesii* into two equal nearly conical lobes.

Locality and stratigraphical range.—This species was collected by my friend the Rev. P. B. Brodie from the bed of clay resting on the Stonesfield slate at Sevenhampton Common, along with *Acrosalenia spinosa* and *Pecten varians*; this bed occupies the same relative position in other parts of Gloucestershire, and is probably the basal clay band on which the shelly freestone beds of the Great Oolite rest. I only know the solitary specimen before me; in Germany, Count Münster found it in the Jurakalk of Baireuth.

History.—First figured and described as an *Echinus* by Goldfuss. I am not aware of its having been noticed before as a British fossil.

My thanks are especially due to Mr. W. H. Baily for the pains he has taken with the beautiful figures which accompany this paper, the original specimens of which are in my cabinet.

On the Cassidulidæ of the Oolites, with descriptions of some new species of that family. By THOMAS WRIGHT, M.D. &c.

READ 16TH SEPTEMBER 1851.

SINCE the publication of my paper* on the "Cidaridæ of the Oolites," I have collected two *Acrosalenia* which are quite new, and an *Echinus* of the same species as one occurring in the Corallian stage of Besançon, but very rare as a British fossil.

I now purpose describing these Cidaridæ as a supplement to that paper, before entering upon the study of the Cassidulidæ, which forms the subject of the present communication.

Acrosalenia decorata†, Haime.

Test hemispherical, depressed, outline subpentagonal; ambulacral areæ convex and prominent, the anterior and posterior pair slightly sinuous, having two rows of small perforated marginal tubercles, and the intermediate surface covered with close-set granulations; interambulacral areæ with two ranges of primary tubercles from 10-12 in a range, the four central pairs being alone fully developed; apical disc large, sur-anal plate central, anus behind encroaching on the single ovarian plate, which is rudimentary and projects far into the single area; base very concave; mouth large, in a deep depression;

* Ann. and Mag. Nat. Hist. 2nd Series, vol. viii. p. 421.

† I had given this *Acrosalenia* another specific name, but just as my MS. was about to be sent to press, I learned that it had been described by M. Jules Haime, under the name *Milnia decorata*, either in the 'Annales des Sciences Nat.,' or in the 'Bulletin de la Soc. Géologique de France,' to neither of which works I can at present refer. I learn further that Professor Forbes has had it drawn and engraved with all the details, and will describe it in the forthcoming decade of his 'Memoirs of the Geological Survey,' under the name *A. decorata*. I have therefore withdrawn my name and the figure I had intended to give, as the multiplication of specific names is at all times to be deplored, but more especially so in our day, when a mania for the creation of species is so rife; I have therefore much pleasure in referring to the forthcoming decade of the 'Memoirs' for elaborate figures of the anatomy of the test of this beautiful species.

primary spines long, smooth, slender and tapering ; secondary spines small, hair-like, numerous.

Height $\frac{4}{10}$ ths of an inch, transverse diameter $\frac{8}{10}$ ths of an inch.

Description.—This elegant little Urchin is remarkable among its congeners for the pentagonal outline of its test, arising from the flatness of the interambulacral and the prominence and convexity of the ambulacral area, and for exhibiting the bilateral symmetry of the Cidaridæ in a very interesting manner. The ambulacral area are about one-third the width of the interambulacral, the single ambulacrum is quite straight, and the anterior and posterior pairs are slightly sinuous ; the apices of the anterior pair curve gently backwards, and those of the posterior pair upwards and inwards ; two rows of small perforated tubercles alternately occupy the margins of the area, each row containing from 20–24 tubercles, which gradually diminish in size from the basal angle to the apex, the central and intermediate spaces being covered with small close-set granules ; the pores are disposed in single pairs throughout the avenues.

The interambulacral area are three times as wide as the ambulacral, and are so much flattened that they form nearly straight lines at the circumference ; the interambulacra are occupied by two ranges of primary tubercles, about eleven tubercles in each row, which are unequally developed in different regions of the area ; the four ventral pairs are small and nearly of the same size ; the four central pairs are fully developed, though not all of the same volume, whilst the three dorsal pairs are quite rudimentary ; the areolæ of the central tubercles are transversely oblong and vertically confluent ; a zigzag granular band, of four granules deep, occupies the centre of the area, separating the two ranges of tubercles from each other, and little granular bands separate the tubercles from the poriferous avenues ; at the basal angle several secondary tubercles are interspersed among the granulations where the tubercles become rudimentary ; at the dorsal surface the test is covered with small close-set granulations. The apical disc is large and oblong ; it is formed of two anterior and two posterior pair of well-developed ovarian plates, and a single rudimentary ovarian, which extends far down the single interambulacral area, and is much encroached upon by the anal opening, which is in fact formed at the expense of the single ovarian plate. The sur-anal plate is large and composed of several pieces, of which the largest is central ; two others are posterior to it, and four or five smaller pieces form an arch at the anterior border of the anal opening which occupies nearly the whole of the single ovarian plate ; the ocular plates are small and heart-shaped, and articulate with the apices of the ambulacra ; the surface of the

discal plates is covered with the same delicate granular sculpture which adorns the intertubercular parts of the test. The ventral surface is very concave; the mouth-opening is large, about half the diameter of the test, situated in a considerable concavity formed by the ambulacral and interambulacral aræe curving upwards and inwards towards the interior of the test; the margin is decagonal, with nearly equal-sized lobes; the teeth are carinated; the primary spines are cylindrical and tapering, and rather exceed in length the diameter of the test; their surface is sculptured with longitudinal microscopic lines; the secondary spines are small, delicate, hair-like appendages.

Affinities and differences.—*A. decorata* belongs to the group of Salenians having the anal opening situated behind the apical disc; it consequently has affinities with *A. spinosa* and *A. Wiltonii*, which it further resembles in the rudimentary condition of the single ovarian plate, and in the general structure of the ambulacral and interambulacral aræe; it is distinguished however from *A. spinosa* by having a more pentagonal outline, a more rudimentary condition of the dorsal tubercles, a more oblong and irregular-shaped apical disc, with the single ovarian plate projecting further than the others into its corresponding interambulacrum, and the sur-anal plate being formed of many elements instead of one, as in *A. spinosa*. The ventral surface is likewise more concave, the mouth-opening is proportionally larger and lodged in a deeper concavity, and the marginal lobes are more equal-sized than in *A. spinosa*. The same group of diagnostic characters will serve to distinguish *A. decorata* from its other congeners.

Locality and stratigraphical range.—This beautiful *Acrosalenia* was collected in the yellow clays of the Coralline Oolite of Wilts, and I have seen it in the ragstones of the same stage. The test is well preserved in the individual which served for our description, but the apical disc is unfortunately absent. Our description of the disc is given from another specimen.

Acrosalenia Wiltonii, Wright, n. sp. Pl. VII. fig. 4 a-e.

Test hemispherical, sometimes depressed, sides tumid; ambulacral aræe narrow, with two rows of small marginal perforated tubercles; interambulacral aræe about three times the width of the ambulacral, with two ranges of primary tubercles, of which the three middle pairs only attain full development; those at the base are small, and those at the dorsal surface are rudimentary; apical disc convex and prominent; sur-anal plate formed of two large and five small pieces; anal opening be-

hind, excavated out of the single ovarian plate, which is rudimentary, the anterior and posterior pairs of ovarian plates well developed. Basal angle obtuse, from the tumidity of the sides; mouth-opening small, decagonal, with nearly equal-sized marginal lobes.

Height $\frac{1\frac{1}{2}}{80}$ ths of an inch, transverse diameter $\frac{1\frac{1}{2}}{80}$ ths.

Description.—This Urchin is almost always orbicular in the circumference, but the dorsal surface is more or less elevated in different individuals; in general it is hemispherical and depressed at the anal pole; the sides are tumid and gently rounded towards the mouth. The ambulacral areæ preserve a very uniform width through nearly all their extent. Two rows of about sixteen small perforated tubercles are arranged in alternate order on the margins of the areæ, the eight inferior pairs being larger, and the eight superior pairs gradually decreasing in size until they become quite microscopic near the apex; between the marginal tubercles a double row of granules, having a sinuous disposition, occupies the centre of the areæ. The poriferous avenues are gently undulated; on the sides the pores are placed in pairs, but at the base, from their increased numbers, they fall into triple oblique pairs. The interambulacral areæ are three times the width of the ambulacral, and furnished with two ranges of primary tubercles from 9–10 in a range; the three basal pair are small, gradually increasing however in size from the mouth-margin, where they are very small, to blend in with the three middle pairs, which attain their full development. The seventh pair are smaller than the sixth, and the eighth and ninth pairs become suddenly small and even rudimentary. The space between the tubercles is of moderate width, and is occupied by a zigzag band formed of four rows of granules, those which are arranged on the borders of the areolæ are larger and are likewise perforated; the primary tubercular ranges are separated from the poriferous avenues by a single row of small perforated granules, which form a succession of arches over the ambulacral border of the areolæ. The upper surface of the test is covered with small close-set granulations, among which the rudimentary tubercles stand conspicuous. The apical disc is rather prominent and convex, and is fortunately preserved in an otherwise imperfect specimen (Pl. VII. fig. 4 d): but for this circumstance, we should have been in the dark touching the natural relations of the species; it is formed of an anterior and a posterior pair of moderately-sized ovarian plates, and a rudimentary single ovarian plate. The sur-anal plate is very curious, and is composed of two unequal-sized pentagonal pieces united

with the anterior and posterior ovarials, and six small pieces forming an arch which spans from the right to the left posterior pair of ovarials, and forms the anterior border of the anus; the posterior pair of ocular plates forms the lateral, and the single rudimentary ovarian plate the posterior boundary of the anal opening, which is transversely oblong, slightly excentral, and consequently placed behind the compound sur-anal plate. The ocular plates are heart-shaped and of a moderate size, and their eyeholes are very minute. The surface of the discal plates is covered with small granulations. The tumid sides are gently rounded towards the base. The mouth-opening is small, being rather more than one-third the diameter of the test; its margin is decagonal, with nearly equal-sized lobes, those of the ambulacra being the widest. The fragment of a primary spine before me is cylindrical and smooth, and judging from its thickness must have been long. The secondary spines are short, prickle-shaped, and sculptured with fine longitudinal lines (4 e).

Affinities and differences.—The preservation of the apical disc proves that the natural affinity of this species is with *A. spinosa* and *A. decorata*, whilst in the general form and structure of the test, *A. Wiltonii* most resembles *A. hemicydaroides*; but it differs from that species in having the anal opening behind the sur-anal plate, whereas in *A. hemicydaroides* it is situated before it.

Locality and stratigraphical range.—This *Acrosalenia* was collected from the Cornbrash near Sutton Benger, Wilts; it appears to be rare. I dedicate this species to my friend John Wilton, Esq., of Gloucester.

Echinus gyratus, Agassiz.

SYN. *Echinus gyratus*, Echin. Foss. de la Suisse, part 2. p. 87. tab. 23. fig. 43–46.

Echinus petallatus, M'Coy, Annals Nat. Hist. vol. ii. p. 409, 2nd Series.

Test hemispherical, more or less elevated, with an orbicular circumference, divided into fifteen slightly convex lobes; ambulacral areæ half the width of the interambulacral, with two complete rows of marginal tubercles extending from the mouth to the apical disc, and two incomplete rows of central tubercles occupying about two-thirds of the sides thereof; interambulacral areæ with a smooth concave median space extending from the disc to near the basal angle; each of the two lobes formed thereby has one complete central range of tubercles, and two lateral incomplete ranges of tubercles; at the circumference of the test there are twelve rows of tuber-

cles ; apical disc well developed ; anal opening central ; base flat ; mouth-opening large, almost pentagonal from the length of the arches over the ambulacra ; spines unknown.

Height $\frac{1}{2}$ ths of an inch, transverse diameter 1 inch and $\frac{2}{3}$ ths.

Description.—The distinguishing characters of this beautiful Urchin are so prominent, that it forms a well-marked species of a genus, in which in general specific distinctions are far from being clearly defined. The test is hemispherical and elevated at the vertex, and is very regularly formed ; its surface is divided into fifteen nearly equal-sized lobes grouped into five divisions of three lobes each, of which the ambulacrum forms the centre lobe, and the half of the adjoining interambulacra the lateral lobes. The distinctive character of the test consists in the median concave depression in the centre of the interambulacra which extends from near the circumference to the apex, and is entirely destitute of tubercles and granules ; near the circumference however small tubercles occupy the space, and at this point we observe twelve tubercles in a row in the interambulacra. Each area is thus divided into two convex lobes ; in each lobe one complete range of tubercles extends from the mouth to the vertex, and two incomplete rows occupy each side thereof ; at the widest part of the area only a few additional tubercles are introduced. The ambulacra are about one half the width of the interambulacra, and are furnished with two complete rows of marginal tubercles, and two incomplete rows which occupy the central parts of the sides ; around the circumference of the tubercles, forming the complete ranges, a series of small granules are disposed in circles, and similar moniliform granular rings surround the larger tubercles of the incomplete rows. The tubercles of both areas are large and prominent, and their surfaces are highly polished ; those of the base are larger than those of the sides ; and, as a general remark, it may be stated that the test is uniformly very granular.

The pores are disposed in rather wide avenues in triple oblique pairs, among which, some of the small granules encircling the marginal tubercles of the ambulacra are scattered. The apical disc is large and central ; the anterior pair of ovarian plates are the smallest, the posterior pair are larger, and the single madreporiform plate is the largest of the disc ; the ocular plates are small and pentagonal, and stand distinctly out from the angles of the ovarials ; the eyeholes are small and central ; the anal opening is large and transversely oblong ; the surface of the ovarian and ocular plates is covered with small granules, and the spongy madreporiform body is prominent and convex.

The mouth-opening is very large, and has more the appearance of being pentagonal than decagonal, from the extreme shortness of the arches over the termination of the interambulacral, and the disproportionate span of those over the ambulacral areas.

Affinities and differences.—This *Echinus* resembles some granular varieties of *E. perlatus*, and the concave median space in the interambulacra of that species increases the resemblance thereto; but the following structural differences afford good diagnostic characters by which the two forms may always be distinguished from each other. In *E. gyratus* the naked concave median space in the interambulacra is wider, and extends much further down the sides than the corresponding space in *E. perlatus*. The ambulacral aræ have four rows of tubercles in *E. gyratus*, and only two rows in *E. perlatus*. The lateral tubercles in the secondary ranges of the interambulacral aræ are nearly as large as those of the complete ranges of the same in *E. gyratus*, whereas the secondary ranges of the corresponding aræ in *E. perlatus* are smaller and even sometimes rudimentary. The tubercles themselves in *E. gyratus* are more prominent and convex, and are more highly polished than those of *E. perlatus*. The same group of characters enables us to distinguish this species from its other congeners. Prof. M'Coy has described an *Echinus* from the Coralline Oolite of Wilts under the name *E. petallatus*, which we consider to be identical with *E. gyratus*: we cannot admit that an increased elevation of the test, or a greater extent of the naked surface of the plates, are sufficient characters to justify the separation of species: our specimen was obtained from the same stage and locality, and as we are not acquainted with any other *Echinus* for which it could be mistaken, we have no doubt of its identity with the *E. petallatus*.

Locality and stratigraphical range.—This Urchin was collected from the clay beds of the Coralline Oolite of Wilts; at present we are not aware of its having been found in any other locality in this country. Its foreign distribution is likewise limited to the "Terrain à chailles" or Corallian stage of Besançon.

History.—First described by M. Agassiz in his 'Echinodermes Fossiles de la Suisse,' where it is beautifully and faithfully figured; afterwards noticed by Prof. M'Coy under the name *E. petallatus*, from the Coralline Oolite of Wilts. We are inclined to think that this Urchin is the same which was figured by Parkinson in the 3rd vol. of his 'Organic Remains,' and described as an "Echinite from France."

On the CASSIDULIDÆ.

The Cassidulidæ have been recently dismembered by Agassiz and Desor from the family Clypeastroidæ, in consequence of the mouth of the Cassidulidæ being destitute of the jaws and teeth possessed by the true Clypeastroidæ*: how far this supposed negative edentulous character is of sufficient zoological importance to justify the separation of the Cassidulidæ from the great natural family which they resemble in most of the important points of their structure, it is not our intention on the present occasion to inquire; it has however the palæontological merit of grouping together many genera of Echinida closely related to each other by structural affinities as well as by their limited distribution in time.

Family CASSIDULIDÆ.

Urchins having an oblong, subpentagonal or orbicular circumference, generally clypeiform, with a uniform convex dorsal surface, mostly depressed, but sometimes elevated or conoidal; the shell is of moderate thickness, and its surface is covered with small tubercles and granules. The tubercles are smaller on the dorsal than on the ventral surface, and are surrounded by a circular depression; sometimes the tubercles are arranged in vertical ranges, but in general they are sporadical. The granules are entirely microscopic, and occupy the intertubercular spaces; to the whole of the tubercles small filiform spines are attached. The ambulacral aræ are narrow, and the pores are disposed in close-set pairs, forming a single file as in the *Galerites*; or they are placed at some distance apart, and united by transverse sutures, which occasions the petaloid forms seen on the dorsal surface of the test of the *Nucleolites*.

The mouth is central or subcentral, and is sometimes armed with jaws and teeth; in some genera its margin is divided into ten lobes; in others it is edentulous and the opening is round or pentagonal, and sometimes surrounded by five prominent lobes, formed by the folding inwards of the terminal portions of the interambulacra. The anal opening is large, and situated on the dorsal or ventral surface; it is rarely marginal, often infra-marginal, and when dorsal is lodged in a valley. The apical disc is formed of four perforated ovarian plates and a single imperforate

* This generalization is not strictly in accordance with the facts. The existence of a dental apparatus was discovered by Mr. Chas. Stokes in *Galerites albogalerus*, and specimens of this cretaceous Urchin, with the lantern and teeth, are in the cabinets of Messrs. Stokes and Bowerbank. It is probable that all the members of the *Galerite* group with a central decagonal mouth-opening possessed a similar dental armature.

ovarial; the madreporiform body is generally situated in the centre, around which the ovarials are arranged; the five ocular plates are small, and lodged at the apices of the ambulacra. From the structure of the ambulacra we divide the Cassidulidæ into two groups.

1st GROUP OF ECHINONEIDES*.

Ambulacra simple, uniform throughout; mouth circular, decagonal or pentagonal, without prominent lobes.

Genus PYGASTER, Agassiz.

Test subpentagonal, more or less depressed; surface of the plates covered with small perforated tubercles, raised on mammillated and crenulated eminences, disposed in regular vertical rows, and surrounded by areolæ with encircling granules; the tubercles attain their greatest development at the circumference and base of the test; ambulacral areæ with four or six rows of tubercles; interambulacral areæ with from 12–20 rows; mouth-opening central and circular, margin divided into ten equal lobes, the notches of which correspond to the sutural junction of the ambulacra with the interambulacra; anal opening very large, occupying the upper half of the single interambulacral area; pores arranged in simple pairs throughout the avenues; apical disc unknown. This genus is extinct; the species are distributed throughout the Oolitic and Cretaceous rocks.

Pygaster semisulcatus? Phillips.

SYN. *Galerites umbrella*?, Lam. Anim. sans Vert. t. iii. p. 25.

Nucleolites umbrella, DeFrance, Dict. So. Nat. t. xviii. p. 87.

Clypeus semisulcatus, Phillips, Geol. of York. part 1. pl. 3. fig. 17.

Clypeus ornatus, Buck. Murchison's Geol. of Cheltenham, 2nd ed. p. 95.

Test subpentagonal, depressed; interambulacra with from 16–18 rows of tubercles at the circumference; ambulacra prominent and convex, with four rows of tubercles; anus very large, occupying nearly the upper half of the single interambulacrum; mouth deeply notched; spines short, subulate, and longitudinally striated.

Height 1 inch and $\frac{1}{10}$ ths, antero-posterior diameter 3 inches, transverse diameter 3 inches.

Description.—The imperfect condition of the test of *Pygaster*

* The group of Echinoneides comprehends eleven genera: *Echinoneus*, Van Phels; *Pygaster*, Agass.; *Holactypus*, Desor; *Discoidea*, Gray; *Galerites*, Lam.; *Pyrina*, Desml.; *Globator*, Agass.; *Caratomus*, Agass.; *Nucleopygus*, Agass.; *Hyboclypus*, Agass.; *Dysaster*, Agass.

umbrella figured by Agassiz, does not enable us satisfactorily to compare that Urchin with our specimen, and leaves a doubt upon our mind whether the Urchin known to Lamarck was identical with this species. We have examples corresponding in form, size, and comparative dimensions with Agassiz's figure, but the absence of the sculpture of the plates in the Swiss specimen leaves the question in doubt: through the kindness of Professor Forbes we have compared our Urchins with the one sent by Mr. Phillips from Yorkshire, and have proved their identity; but having had no opportunity of examining typical foreign specimens, we have provisionally adopted Mr. Phillips's specific name. The ambulacra are one-fourth part the width of the interambulacra; they are prominent and convex, and furnished with four rows of tubercles, the marginal rows extending from the mouth to the apical disc, whilst the internal rows disappear near the mouth and about half-way up the dorsal surface; the interambulacra at the circumference have from 18-20 rows of tubercles; the number however gradually diminishes between the basal angle and the mouth, and the circumference and the apical disc, so that from two to four rows only extend from the mouth to the vertex. The mammillated eminences on which the tubercles are placed are encircled by smooth areolæ, surrounded by small granules arranged round their circumference, which gives the intertubercular surface of the plates a granular structure. The tubercles are small, prominent and perforated, and the summits of the mammæ are crenulated as in the Cidaridæ. These characters added to others, as the regularity of the arrangement of the tubercles, and the dorsal position of the anal opening, lead us to consider *Pygaster* as a transition form connecting the Cidaridæ with the Cassidulidæ. The base is concave, and the mouth is central and situated in a considerable depression; the opening is about one-fifth the diameter of the test at the circumference; its margin is divided into ten nearly equal-sized lobes, the angles of which correspond to the divisional sutural lines between the ambulacra and the interambulacra. The anus is a large oval opening in the upper half of the single interambulacrum, forming a great gap in this part of the test, and constituting one of the most important characters of the genus. In the living animal this space was probably occupied by a membrane, but in the fossil condition it has the appearance of the test having been fractured and lost. The apical disc is absent in all the specimens of *Pygaster* that have passed through our hands. The pores are set closely together in pairs throughout the entire range of the avenues; sometimes they have a slightly oblique disposition. The spines adhering to the fine specimen before me are short, needle-shaped, and delicately striated longitudinally.

Affinities and differences.—*P. semisulcatus* most nearly resembles *P. umbrella*; we have before us specimens which are well represented by Agassiz's figure; but the loss of the tubercles from the Swiss specimen leaves the question of their identity an open one, as we regard the special form of sculpture of the test a most important specific character. *P. semisulcatus* differs from *P. Morrisii* in having narrower ambulacra and fewer tubercles on both areas; the size and number of the tubercles and the depression of the test afford distinguishing characters between it and *P. conoideus*.

Locality and stratigraphical range.—This Urchin is abundant in the lower ferruginous beds, "the Pea-grit" of the Inferior Oolite at Crickley, Birdlip, and Leckhampton Hills, and in the shelly freestone of the same localities, and I have collected small specimens from the planking beds of the Great Oolite at Minchinhampton; in Yorkshire it was collected by Mr. Phillips* from the Coralline Oolite of Malton and Scarborough. In the Pea-grit it is associated with *Diadema depressum*, *Hybochypus agariciformis*, *Rhynchonella Wrightii*, *Thecidea triangularis*, *Terebratula simplex*, and *Ter. plicata*.

History.—This species was figured by Mr. Phillips, but not described, in his 'Geology of Yorkshire.' The absence of typical foreign specimens does not enable us to decide whether the *Galerites umbrella* of Lamarck is identical with Mr. Phillips's species. The fine and nearly perfect specimen before me has been figured by Professor Forbes for the 4th Decade of his admirable 'Illustrations of British Fossils;' for this reason we have not given a drawing of the species.

Pygaster conoideus, Wright, n. sp. Pl. VII. fig. 1 a-d.

Test conoidal, with a pentagonal circumference; ambulacra narrow and prominent, with two rows of marginal tubercles and two imperfect rows of central tubercles; interambulacra four times the width of the ambulacra, with very small tubercles and a scanty granulation on the surface of the plates; anal opening comparatively small, occupying the upper third of the single interambulacrum; base flat.

Height 1 inch and $\frac{5}{10}$ ths, antero-posterior diameter 2 inches and $\frac{2}{10}$ ths, transverse diameter 2 inches and $\frac{4}{10}$ ths.

Description.—This Urchin is remarkable for its conoidal form, the anterior and lateral walls of the test forming angles of from 50° to 55° with the base, and the posterior wall an angle of about 42° (fig. 1 b). The ambulacra are narrow and prominent, having

* Geol. of Yorkshire, Part 1. p. 127.

two complete rows of tubercles arranged on the sides of the areæ (fig. 1 c), and two incomplete rows of tubercles internal to them, which are neither so regular in their arrangement as the marginal rows, nor do they extend beyond the lower half of the areæ; the single ambulacrum is perpendicular; the anterior pair arch gently upwards and backwards, whilst the posterior pair rise forwards and upwards for three parts of their course, and then make a short curve round the anal opening, and terminate at the lateral border thereof. The pairs of pores are disposed very closely together in well-defined narrow avenues, which form distinct boundaries between the ambulacra and the interambulacra; at the basal angle the interambulacral are four times the width of the ambulacral areæ; the plates (fig. 1 d) are adorned with rather irregular rows of very small tubercles varying in number from four to sixteen in a row in different parts of the area; the smooth areolæ around the tubercles are very superficial; their circumference is encircled by rows of microscopic granules: besides these granular circles, there is scarcely any other sculpture on the plates, which gives a great smoothness to the test of *P. conoideus* when compared with that of *P. semisulcatus*. The anal opening (fig. 1 a) when compared with that of the latter is proportionally small, occupying rather more than the upper third of the single interambulacrum; the portion of the area below the vent is flattened and slightly concave. The base is covered with the oolitic matrix, which here forms a hard crystalline rock, and cannot be removed without fracturing the test; enough is exposed however to show that the base is slightly concave, and that the tubercles are much better developed in this region than on the dorsal surface. The apical disc is absent, and we know nothing of the spines.

Affinities and differences.—This Urchin resembles *P. semisulcatus* in its pentagonal form and in the number of the tubercles on the areæ; but is distinguished from that common species by the greater prominence of the ambulacra, the smallness of the tubercles, the superficiality of the areolæ, the microscopic character of the granulations, the elevated conoidal form of the test, and the smallness of the anal opening; it is a rare species, the specimen which we figure being the only one we have ever met with in our researches; a second specimen is in the cabinet of our friend John Lycett, Esq.

Locality and stratigraphical range.—I found this Urchin in the Pea-grit of Crickley Hill. Mr. Lycett's specimen came from the Inferior Oolite near Stroud.

Pygaster Morrisii, Wright, n. sp. Pl. VIII. fig. 1 a-d.

Test much depressed and pentagonal, basal angle tumid; ambulacra wide, prominent and convex, with six rows of tubercles;

interambulacra with from 20 to 22 rows of tubercles at the circumference; base flat, depressed towards the centre; the single interambulacrum truncated posteriorly; anal opening large, occupying three-fourths of its upper surface.

Height $\frac{2}{3}$ ths of an inch, antero-posterior diameter 2 inches and $\frac{5}{8}$ ths, transverse diameter 2 inches and $\frac{5}{8}$ ths.

Description.—The ambulacral areæ of this Urchin are wide, convex, and prominent, and form an exception to Agassiz's generalization, that in the genus *Pygaster* the ambulacra are furnished with only four rows of tubercles, for in this species there are six well-developed rows at the circumference of the test (fig. 1 c); the two marginal rows extend from the mouth to the vertex, the two middle rows commence at a short distance from the mouth and terminate at a short distance from the vertex, and the two internal rows commence about four lines above and extend about the same distance beyond the basal angle. The interambulacral areæ are three times the width of the ambulacral, and are furnished with twenty-two rows of tubercles at the circumference of the test; they attain their greatest development at the base of the areæ, and are arranged so uniformly, and disposed so closely together, that they present somewhat the appearance of a mosaic work (fig. 1 d); the areolæ are deeply sculptured out of the plates, and surrounded by circles of very small granules; of the twenty-two rows of tubercles which occupy the area at the circumference, only six, and those the three central rows of each column, extend from the mouth to the vertex, the others are limited to shorter distances, the length of their range being in proportion to their distance from the margin of the columns. The poriferous avenues are narrow, and the pores are small and set closely together in pairs. The basal angle is tumid (fig. 1 b); the base is flat and depressed towards the centre; in this depression the mouth is situated; the opening is small, being only one-sixth the diameter of the test at the circumference. The anus is a large oblong opening (fig. 1 a), occupying at least the upper three-fourths of the single interambulacrum. The apical disc is absent; the spines are short, needle-shaped, and finely striated longitudinally. The test is very thick.

Affinities and differences.—This species resembles *P. laganoides*, Agassiz, in its depressed form, obtuse basal angle, and truncated single interambulacrum; but *P. Morrisii* is distinguished from *P. laganoides* in possessing a greater number of tubercles in both areæ, *P. laganoides* having four rows in the ambulacral and twelve in the interambulacral, whilst in *P. Morrisii* the corresponding areæ possess six and twenty-two. We know no other species among its congeners for which it could be mistaken.

Locality and stratigraphical range.—This rare species was collected from the Cornbrash at Stanton, Wilts, and is the only specimen we know from that stratum. We have seen a *Pygaster* from the Great Oolite near Cirencester, which apparently belongs to our species; it was a crushed specimen, but the number of the tubercles on the areæ was the same as in our species.

Genus *HOLECTYPUS*, Desor.

Test circular, more or less hemispherical, conical or subconical, always tumid; mouth central and decagonal; anal opening large, inferior, infra-marginal, rarely marginal, sometimes occupying the entire space between the mouth and the border; ambulacra simple, continuous and radiant; avenues with a single pair of pores throughout; tubercles small, perforated and crenulated, disposed in a regular series; apical disc central and vertical, composed of four perforated and a single imperforated oval plate, a central madreporiform body, and five ocular plates; the internal walls of the test *without* projecting ribs.

The genus *Holactypus* was formed by M. Desor for those *Discoidea* which have no projecting processes or ribs on the inner wall of their test. The species of which the group is composed are found in the oolitic and lower cretaceous rocks. They constitute a transition from the *Discoidea* to the typical *Galerites*, and according to the views of Professor Forbes "form a section or subgenus of the genus *Galerites*, more valuable on account of their palæontological merits and limited distribution in time (being the main characteristic of the Oolitic period) than for the zoological importance of the characters of their organization, which are rather transitional than distinctive."

Holactypus depressus, Desor.

SYN. *Galerites depressus*, Lamk. Animaux sans Vert. tome iii. p. 21. no. 7; Desmoulins, Table Synopt. p. 254; Goldfuss, Petrefact. Ger. tab. 41. p. 129; Koch and Dunker, N. D. Oolit. tab. 4. fig. 2.

Discoidea depressa, Agassiz, Cat. Syst. p. 7; Echin. Foss. de la Suisse, tab. 13 bis, fig. 7-13.

Holactypus depressus, Desor, Catal. raisonné des Echinides, A. S. N. tom. vii. 3rd Series.

Test hemispherical, more or less depressed, sometimes conical; circumference circular or subpentagonal; base concave; tubercles small on the dorsal surface, larger on the base; anal opening pyriform, infra-marginal; apex directed towards the mouth.

Height $\frac{7}{10}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{1}{10}$ ths, transverse diameter 1 inch and $\frac{1}{10}$ ths (Inferior Oolite spe-

cimens). Height $\frac{8}{10}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{8}{10}$ ths, transverse diameter 1 inch and $\frac{7}{10}$ ths (Cornbrash specimens).

Description.—The inconsiderable prominence of the ambulacra of this Urchin gives the circumference a subcircular outline; the areas are furnished with from six to eight rows of tubercles, four of which only extend from the mouth to the vertex; the other rows disappear at various distances from the circumference, where they are most fully developed. The interambulacra are twice and a half the width of the ambulacra, and furnished at the circumference with sixteen rows of tubercles, a few of which only form distinct horizontal ranges on the dorsal surface of the test; the perforated tubercles are encircled with fine granulations which cover likewise the intertubercular surface of the plates; the base is concave, and the tubercles of both areas attain their greatest development in this region, presenting in their size a remarkable contrast to the microscopic character of those occupying the upper surface of the test.

The apical disc is central, and occupies the vertex; it is composed of four perforated ovarian plates, and a single imperforate plate with five ocular plates; the madreporiform body is largely developed and projects from the single imperforate ovarian towards the centre of the disc, where the line of suture between the other plates is not clearly defined; the madreporiform body has the appearance of a central spongy mass, round which the ovarian and ocular plates are disposed, and has been figured and described as such by Agassiz and Desor; but specimens before me, from the Inferior Oolite of Dundry and the Cornbrash of Wilts, prove this to be an error. The single ovarian plate, with its madreporiform body, is of an irregular pentagonal form, the spongy portion projecting inwards to the centre; the anterior and posterior pair of ovarian plates are of a pentagonal form, and are perforated at their apices for the passage of ducts; the ocular plates are likewise pentagonal and wedged between the ovarian plates at the summits of the ambulacra, where the eyeholes are situated. The mouth occupies the centre of the concave base, but is rather nearer the anterior than the posterior border; it is about one-third the diameter of the test, and its margin is divided into ten lobes. The anal opening is large, occupying nearly all the basal portion of the single interambulacrum; it is of a pyriform shape, having the apex directed towards the mouth, and the round base towards the border of the test. The poriferous avenues are occupied by a row of pores placed in pairs, and extending without interruption from the margin of the mouth to the apical disc. The spines are unknown.

Affinities and differences.—This species resembles *H. hemisphericus* in its general outline, but is well distinguished from it

by the position of the anal opening. In *H. depressus* the anus is infra-marginal with the apex directed inwards, whilst in *H. hemisphericus* that opening is marginal with the apex directed outwards. The specimens from the Inferior Oolite are in general smaller and more tumid than those obtained from the Cornbrash, which have a much greater diameter, but are proportionally more depressed and have a more acute basal angle.

Locality and stratigraphical range.—I have collected this Urchin from the upper beds of the Inferior Oolite along the entire range of the Cotteswolds. Dundry, Wootton-under-Edge, Stinchcombe, Rodborough, Coopers, Birdlip, Shurdington, Leckhampton and Winchcombe Hills may be named as good localities in Gloucestershire. I have obtained the large specimens from the Cornbrash near Kemble Tunnel, Great Western Railway, and from Stanton, Wilts, and near Woodstock, Oxon. Mr. Phillips has found it in the Cornbrash of Yorkshire. The foreign localities are, "the corallian stage of Liesberg, environs of Bamberg, Muttentz, Metz, the Oxfordian stage of Vivoin and Chauffour (Sarthe), d'Alençon, Boulogne, Mamers, Châtillon-sur-Seine and Latrency (Haute Marne)*." Goldfuss assigns as its localities the upper and middle beds of the Jurakalk in Bavaria and Würtemberg†. Koch and Dunker have found it in the sandy dolomitic limestone of Tönnjesberges in Hanover‡.

History.—*Holactypus depressus* has been long known to palæontologists, being very generally found in the lower and middle divisions of the Jurassic strata throughout Europe; it is figured in the works of Goldfuss, Koch and Dunker, and Agassiz: the figures of the latter author are the most correct and abundant in details.

Holactypus hemisphericus, Desor.

SYN. *Discoidea hemisphærica*, Agassiz, Cat. Syst. p. 7; Desor, Monogr. des Galerites, p. 71. pl. 8. fig. 4-7.

Holactypus hemisphericus, Agass. and Desor, Cat. raisonné des Echinides, A. S. N. vol. vii. p. 146, 3rd Series.

Galerites hemisphæricus, Forbes, Memoirs of the Geol. Survey, Decade 3. pl. 6.

Var. *a. Depressus.*—*Discoidea marginalis*, M'Coy, Ann. Nat. Hist. vol. ii. p. 413, 2nd Series.

Var. *b. Conicus, anus valde marginalis.*—*Holactypus Devauxianus*, Cotteau, Etudes sur les Echinides fossiles, p. 46. pl. 2. fig. 7-9.

Test tumid, hemispherical, more or less depressed; margin rounded; tubercles larger on the ventral than on the dorsal surface, and increased in size around the mouth; single interambulacrum

* Ann. des Sc. nat. tome vii. p. 145, 3rd Series.

† Petrefact. Germaniæ, Part I. p. 130. tab. 41.

‡ N. D. Oolith. Versteinerungen, p. 40. tab. 4. fig. 2.

slightly produced; anal opening pyriform, with the apex directed outwards and upwards, excavated out of the base and border of the single area; base concave; mouth small, nearly central, situated in a depression.

Height $\frac{9}{10}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{8}{10}$ ths, transverse diameter 1 inch and $\frac{1}{10}$ th.

Description.—This Urchin resembles the preceding species in its general outline, but a careful inspection shows that it differs in many important particulars from it. The test is sub-hemispherical, more or less depressed in different individuals; the antero-posterior exceeds the transverse diameter, and the apical disc and the vertex are excentrical, being situated nearer the anterior than the posterior border, thereby occasioning a slight obliquity, which is more or less evident in different individuals; the sides are tumid, and the border is gently rounded. The base is concave and much depressed in the centre, in which concavity the mouth-opening is situated; it is nearer the anterior than the posterior border, and is less than one-third the transverse diameter of the test, its margin being divided into ten nearly equal lobes. The ambulacral aræ taper very gradually; each pair of the small narrow plates supports a tubercle, which occupies the same relative position thereon on every fourth plate, so that the aræ are adorned with six rows of tubercles arranged obliquely in V-shaped lines. The pores form pairs set closely together in single files throughout the avenues; about the middle of the sides there are from four to five pairs of pores opposite each interambulacral plate. The interambulacral aræ are twice and a half the width of the ambulacral; in the specimen before me there are twenty-seven plates in each column; each of the side plates is slightly bent upwards in the middle, whilst those of the base are nearly straight; each plate carries from four to eight tubercles surrounded by circles of minute granules. The tubercles are arranged on the plates in such a manner that they form curved lines on the aræ; they are more closely crowded together at the basal angle, and are fewer in number, but of larger size, around the mouth, where they are set more widely apart; each tubercle is perforated and raised upon a mammillated eminence with a crenulated summit: even the encircling granules exhibit perforations when viewed with a high magnifying lens. The spines are unknown. The apical disc is small, and formed of five ovarial and five ocular plates; the anterior pair of ovarials are the largest, and the right*, which is the

* The Urchin is supposed to be placed *before* the observer, with the anterior border before, the anal border behind; the right and left sides of the test consequently correspond to his.

widest, has attached to its surface a spongy prominent body; the posterior pair are smaller, and both pairs are perforated; the single ovarial is the smallest and is imperforate; the ocular plates are small pentagonal bodies, wedged between the angles formed by the ovarials; they are placed opposite the summits of the ambulacra, and have the eyeholes pierced at their lowest border. The anus is a large opening situated in the margin of the single interambulacrum; it is of a pyriform shape, having the base directed towards the mouth, and the apex extending some distance, about one-fourth part up the side; the proportional size of the opening varies in the suite of specimens before me; in all, however, it is constantly marginal.

Affinities and differences.—This species nearly resembles *H. depressus* in its hemispherical form and general outline; it is readily distinguished from it however in being a little more elongated, in having the anal opening marginal and the vertex and apical disc slightly excentric, but the marginality of the anus is the most important diagnostic character.

Locality and stratigraphical range.—This species was collected at Shurdington Hill with *H. depressus*, where it is rare; it was collected in abundance by Messrs. Bristow and Gapper* along with *Dysaster ringens* and *D. bicordatus* from the sands of the Inferior Oolite in Dorset and Somerset. M. Desor† found it in Normandy in a particular bed of the Calcaire au Polypiers known by the name of Caillasse, and M. Cotteau‡ obtained it from the Inferior Oolite of Tour-du-Prè, associated with *Dysaster ringens* and *Diadema depressum*.

History.—First figured and described by M. Desor in his 'Monograph des Galérites,' and lately exquisitely figured in detail and admirably described by Prof. Forbes in the 3rd Decade of his 'Palæontological Memoirs of the Geological Survey.'

Genus HYBOCLYPUS, Agassiz.

Urchins having a circular, oblong, or subpentagonal circumference, with the dorsal surface in general much depressed. The ambulacral areas meet above at two points as in the genus *Dysaster*; the single and anterior pair of ambulacra terminate at the anterior border of the apical disc, the posterior pair at a short distance from them. The anus is situated in a deep valley extending from the vertex to the posterior border of the test. The base is much undulated; the mouth is excentric, placed nearer the anterior border; it is of a pentagonal form and has no marginal folds. The surface of the test is covered with small close-

* Memoirs of Geol. Survey, Decade iii.

† Monogr. des Galérites, p. 71.

‡ Etudes des Echinides Fossiles, p. 46.

set perforated tubercles, raised on eminences with crenulated summits; the pores are disposed in pairs in a single file. This form is at present known only in a fossil state, and appertains to the Oolitic period.

Hyboclypus agariciformis, Forbes, n. sp.

Test disciform, subpentagonal, and much depressed; ambulacra narrow, the three anterior straight, the posterior pair sinuous; interambulacra unequal and covered with an immense profusion of microscopic tubercles; apical disc central and vertical; anal valley deep with parallel sides, which gradually expand about the middle of the single interambulacrum; mouth-opening small.

Height $\frac{3}{10}$ ths of an inch, antero-posterior and transverse diameters $\frac{3}{10}$ inches and $\frac{1}{10}$ th. One large specimen measures, in the antero-posterior and transverse diameters, $\frac{3}{10}$ inches and $\frac{8}{10}$ ths.

Description.—The outline of this Urchin varies a little in different individuals; in general the antero-posterior equals the transverse diameter, but sometimes the transverse exceeds the antero-posterior diameter. The ambulacra are of unequal width; the single anterior area is the narrowest, and the posterior pair are the widest; each pair of ambulacral plates carry from four to six tubercles, which are so disposed that they form oblique rows of from four to six in a row, which meet in the median line and branch upwards and outwards, forming thereby V-shaped figures. The pores are arranged closely together in pairs on the dorsal surface, but from the basal angle to the mouth they are set wider apart, and fall into triple oblique pairs. The interambulacral areæ are of unequal width; the anterior pair measure at the circumference 1 inch and $\frac{5}{10}$ ths, the posterior pair 1 inch and $\frac{1}{10}$ ths; the single area is $\frac{1}{10}$ th of an inch wider than the posterior pair. The inequality in the width of these areæ causes the subpentagonal form of the test; the interambulacral plates are slightly bent upwards at the middle, and their surface is covered with numerous small tubercles; in an ordinary-sized plate, I have counted 100 tubercles, each of which is perforated and surrounded by an areola. The base is flat and slightly undulated, in consequence of the ambulacra forming straight valleys, and the interambulacra convex conical lobes between the basal angle and the mouth. The oral opening is situated nearer the anterior than the posterior border; it is small, of a pentagonal form, and has the border surrounded by five small lobes formed by the termination of the interambulacral areæ; the tubercles are large and more fully developed on the basal than on the dorsal surface of the test, and the areolæ are seen in this region

to be merely the margins of the depressions in the centre of which the tubercles are placed. The apical disc is situated in the vertex and is nearly central; the plates of which it was formed are absent in all the specimens I have seen; the single and the anterior pair of ambulacra converge around its anterior border, and the posterior pair terminate about two lines from the latter at the posterior and external side of the disc. The single interambulacrum is somewhat wider and longer than the others; the anal opening is situated in its dorsal part in a deep valley with parallel vertical sides covered with tubercles; about the middle of the opening, the valley expands and forms a concave depression in its lower half; the basal portion of the area is slightly produced, and forms a lip-shaped process, which gives a considerable convexity and prominence to the basal angle of this area.

Affinities and differences.—*H. agariciformis* differs so widely from its congeners in our Oolites that it cannot be mistaken for either of them; its shield-shape and depressed vertex distinguish it from *H. gibberulus*, and its dimensions, circular form, and rounded posterior border serve as diagnostic characters between it and *H. caudatus*. From *Pygaster*, with which form it has been erroneously grouped, it is distinguished by the greater number and microscopic character of the tubercles in *Hybochlypus*, the deep anal valley with its parallel vertical walls, and the excentric five-lobed mouth; whereas in *Pygaster* the tubercles are fewer and larger, the anal opening forms a large space without a valley and parallel walls, and the mouth is central, and has its margin divided into ten lobes like *Holcotypus* and all the Cidaridæ.

Locality and stratigraphical range.—This species is tolerably abundant in the lower ferruginous beds, "the Pea-grit" of Leekhampton, Crickley, Birdlip, Coopers, and Cleeve Hills: as far as we at present know, it is not found in the middle division of the Oolites.

History.—This species has been elaborately figured for the 4th decade of Professor Forbes's 'Memoirs of the Geological Survey' from the specimens now before me, and will be described in detail in that work, to which I beg to refer for more ample particulars.

Hybochlypus caudatus, Wright, n. sp. Pl. VII. fig. 2 a-e.

Test oblong, much depressed; single interambulacrum produced into a caudal prolongation; mouth very excentric, near the anterior border; apical disc and vertex slightly excentric, anterior border blunt, posterior border truncated.

Height $\frac{2}{5}$ ths of an inch, antero-posterior diameter 1 inch and

$\frac{2}{10}$ ths, transverse diameter 1 inch and $\frac{1}{10}$ th. The great majority of the specimens average as follows :—

Height $\frac{7}{10}$ ths of an inch, antero-posterior diameter $\frac{1}{2}\frac{5}{8}$ ths of an inch, transverse diameter $\frac{1}{2}\frac{3}{8}$ ths of an inch.

Description.—The test of this elegant little species is covered with tubercles so minute, that without the assistance of a good lens, the observer might suppose that it was altogether destitute of sculpture; the single and anterior pair of ambulacra are straight and very short in consequence of the excentricity of the mouth and vertex, and terminate at the anterior border of the apical disc; the posterior pair are one-seventh longer, and curve upwards, inwards, and forwards on the dorsal surface, terminating by the anal valley at a short distance from the posterior border of the disc. The pores are placed closely together on the dorsal surface, but are situated at wider distances apart at the base.

The interambulacra are of unequal width; the anterior pair are the shortest and narrowest, the posterior pair the widest, and the single area the longest, which is likewise considerably produced into a lip-like process, which curves gently downwards and is abruptly truncated posteriorly. The anal furrow is deep with vertical parallel walls, which gradually expand into two ridges, corresponding with the truncated borders of the lip-like process. The anterior border is blunt, with a slight depression in the middle formed by the single area; the base is concave and slightly undulated; the mouth is situated near the anterior border, and is a simple pentagonal opening without lobes; the tubercles in this region are somewhat larger, but they are fewer in number and arranged with much irregularity on the plates. The apical disc is unfortunately broken in all the specimens we have examined; the space which it occupied is however very small.

Affinities and differences.—*H. caudatus* differs from its congeners by its oblong form, posterior lip-like process formed by the single interambulacral area and its depressed and excentric vertex; it is distinguished from *H. gibberulus* by the absence of the anterior central ridge characterizing that species, and from *H. agariciformis* it is distinctly separated by its oblong form and excentric mouth and anus.

Locality and stratigraphical range.—This is not a common Urchin; it is found occasionally in the lower and upper beds of the Inferior Oolite at Leckhampton, Crickley, and Birdlip Hills, and it occurs occasionally in the planking beds of the Great Oolite at Minchinhampton. The specimens from the latter locality are in general small and not well preserved; the individual which we figure is the largest we have seen.

Hybochypus gibberulus, Agass.

SYN. *Hybochypus gibberulus*, Agassiz, Echinoderm. Foss. de la Suisse, Part 1. p. 75. pl. 13. fig. 10-12; Desor, Monograph des Galérites, p. 84. pl. 13. fig. 12-14.

Test nearly orbicular, elevated and contracted anteriorly, enlarged, depressed, produced and truncated posteriorly; the single ambulacral area the highest, and forming a gibbous crest by an elevation of the anterior pair of interambulacral aræ; anal valley wide and deep; single interambulacrum slightly produced, deflected and truncated; base much undulated; mouth and vertex excentrical.

Height $\frac{1}{10}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{1}{8}$ ths, transverse diameter 1 inch and $\frac{1}{8}$ ths. In consequence of the fracture of the summit of the crest, the true height cannot be exactly ascertained.

Description.—This species is remarkable for the prominent gibbous crest formed by the anterior interambulacral and single ambulacral aræ, and which gives value to its specific name; on the anterior border of the crest a groove is formed which extends from thence to the mouth; the anterior lateral are more contracted than the posterior lateral borders, and the posterior half of the test is less elevated than the anterior half, and gradually declines from the vertex to the single interambulacral area, which is abruptly truncated. The single and the anterior pair of ambulacra form nearly straight lines from the vertex to the circumference; the posterior pair are gently sinuous; the pores are disposed in close-set pairs on the dorsal surface, but are more wide apart at the base. The interambulacral aræ are of unequal width; the anterior pair are the narrowest, the posterior pair are one-third wider than the anterior, and the posterior single area is the widest; its dorsal part is occupied by the anal valley, which is wide and deep above and expanded below, and forms an inconsiderable prominence which is abruptly truncated and much deflected posteriorly; the anus is a large, oval opening, perforated at the extremity of the valley. The mouth is situated immediately under the vertex, and both are slightly excentrical; the mouth-opening has a pentagonal form, and lies in a considerable concavity, the base being much undulated from the convexity of the interambulacra and the straightness of the valleys formed by the ambulacra. In the specimen before me the apical disc is unfortunately broken with the summit of the gibbous crest. The test is very thin, and covered with small homogeneous tubercles, which are larger, more numerous, but less regular on the base than on the dorsal surface; they are all surrounded by a very apparent circular depression.

Affinities and differences.—In its general outline *H. gibberulus* resembles the young of *H. agariciformis*, but its anterior gibbous crest distinguishes it at a glance from that species, and I know of no other form for which it could be mistaken.

Locality and stratigraphical range.—This is a rare Urchin: I know only four British specimens, the best of which, from the cabinet of W. Walton, Esq., of Bath, has served for the foregoing description, and to whom I beg to record my thanks for his courtesy in forwarding it. This Urchin was collected by that gentleman from the Inferior Oolite in the parish of Charlcomb near Bath, from whence three of the four specimens were obtained; the fourth was found in the Inferior Oolite of Dorsetshire, and is in the Museum of Practical Geology.

History.—First figured and described by M. Agassiz, who only knew of two specimens from the Inferior Oolite of Switzerland; afterwards by M. Desor in his valuable monograph on the *Galerites*, and now described as a British fossil for the first time*.

Genus DYSASTER, Agassiz.

Test ovate or subdiscoidal; ambulacra simple, continuous and radiant; the posterior pair separated from the others, and converging to form a summit at some distance behind that formed at the apical disc by the antero-lateral pair and anterior single ambulacrum which gives value to the name *Dysaster*. Upper surface of the test smooth and convex, under surface much undulated from the convexity of the interambulacra and the straightness of the ambulacra. Tubercles small, mammillated and perforate, and surrounded by a circular depression; apical disc situated at the junction of the three anterior ambulacra, and formed of four perforated ovarian plates which are intimately soldered

* After the first part of this paper was printed, I met with a specimen of *Hyboclypeus caudatus* with the apical disc preserved *in situ*, which I regret was not found before the plate containing the details of the anatomy of that species was completed. The disc is formed of two small anterior ovarian plates, the right plate supporting the madreporiform body, and two larger posterior ovarian plates; between them and occupying the centre of the disc are four small rhomboidal plates, which probably represent the single ovarian plate composed of two valves, and the two posterior ocular plates displaced from their normal position in consequence of the posterior pair of ambulacra terminating in this genus at a short distance behind the apical disc; at the summits of the single and anterior pair of ambulacra are three small ocular plates with distinct eye-holes; the posterior ambulacra have no ocular plates at their summits; these elements according to my view are transposed to the centre of the disc to give greater expansion to the structure in this region.

Pygaster Morrisii I have dedicated to my friend John Morris, Esq., one of the learned authors of a Monograph of the Mollusca of the Great Oolite.

to the adjoining portion of the test, and having the madreporiform body on the surface of the right anterior plate; there are three ocular plates at the summits of the ambulacra with small eyeholes in depressions thereof; base concave and much undulated; mouth excentral, simple and pentagonal, situated near the anterior border; anus oblong or pyriform, marginal or submarginal, situated at the posterior surface, and sometimes encircled by the postero-lateral ambulacra.

Dysaster ringens, Agassiz.

SYN. *Dysaster ringens*, Agassiz, Echin. Foss. Suisse, Part 1. p. 5. tab. 1. fig. 7-11; Agass. Cat. Syst. p. 3; Desor, Monograph des Dysaster, p. 24. tab. 1. fig. 13-17; Cotteau, Etudes des Echin. Foss. p. 46. tab. 2. fig. 10-13; Agassiz and Desor, Catalog. raisonné, A. S. N. tome viii. p. 33; Forbes, Mem. Geol. Surv. Decade iii. pl. 9.

Collyrites ringens, Desmoulins, 3rd Mém. sur les Echin. p. 368.

Dysaster Eudesii, Agassiz, Cat. Syst. p. 3; Desor, Monogr. des Dysaster, p. 23. t. 1. fig. 5-12.

Dysaster subringens, McCoy, Annals Nat. Hist. 2nd Series, vol. ii. p. 415.

Test suborbicular or subpentagonal, rounded anteriorly, rostrated posteriorly; dorsal surface convex and depressed; sides tumid; vertex nearly central; ambulacra widely disjoined, posterior pair forming an arch above the anal opening; anus pyriform, marginal, and situated in a terminal sulcus; base concave, much undulated; interambulacra tumid, the single posterior area very prominent and much deflected; mouth small, subcentral and subpentagonal.

Height $\frac{7}{10}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{1}{10}$ th, transverse diameter 1 inch. As this Urchin presents very variable proportions, we subjoin the following table of the dimensions of eight specimens from the Bridport Oolite by Professor Forbes* in inches and twelfths:—

	A.	B.	C.	D.	E.	F.	G.	H.
Length	$1\frac{1}{12}$	$1\frac{1}{12}$	$0\frac{11}{12}$	$0\frac{8}{12}$	$0\frac{13}{12}$	$0\frac{9}{12}$	$0\frac{10}{12}$	$0\frac{11}{12}$
Breadth	1	$1\frac{1}{12}$	$0\frac{11}{12}$	$0\frac{8}{12}$	$0\frac{8}{12}$	$0\frac{9}{12}$	$0\frac{10}{12}$	$0\frac{11}{12}$
Thickness . .	$0\frac{6}{12}$	$0\frac{8}{12}$	$0\frac{7}{12}$	$0\frac{5}{12}$	$0\frac{5}{12}$	$0\frac{5}{12}$	$0\frac{5}{12}$	$0\frac{7}{12}$

Description.—The preceding table of dimensions shows how much the general outline of *D. ringens* varies, being nearly orbi-

* Memoirs Geol. Survey, Decade iii. pl. 9.

cular, subpentagonal or oblong, with almost every intermediate form blending the two extremes in different individuals; the dorsal surface is uniformly smooth and convex, elevated posteriorly, gently declined anteriorly, and more or less depressed, the vertex being situated in general nearer the posterior than the anterior border; the sides are tumid, the anterior part is flattened, and the posterior is produced; the antero-lateral region is narrower than the postero-lateral; the prominence of the interambulacra in some individuals produces the subpentagonal varieties. The ventral surface is very unequal, the convexity of the interambulacra amounting to nodulose eminences; the posterior single area in particular is very gibbous, prominent, and much deflected; its posterior surface is truncated and channelled to form the anal valley, which is bounded by two ridges, commencing at the apices of the posterior ambulacra, and passing downwards and outwards towards the base, where they may be traced on the summit of the gibbous area as far as the mouth; in the upper part of the marginal valley and nearly on a level with the dorsal surface the anal opening is situated, having a pyriform shape, with the apex directed upwards. The ambulacra are of unequal width, the posterior pair being the widest; the anterior areas are about the same width; the single ambulacrum is gently sinuous, the antero-laterals curve gracefully towards each other, and the three areas converge at the apical disc near the centre of the dorsal surface; the posterior pair are somewhat wider than the others, they curve gracefully round the single interambulacrum, form an arch over its produced and truncated border, and converge above the anal opening; the ambulacra are all complete, and pass continuously from the mouth to the two dorsal summits; they are formed of pairs of small plates, about one-fourth the depth of the interambulacral plates, each plate being perforated at its outer side with two small pores; the ambulacra become wider about the mouth, and the pores increase in number, forming three oblique series of three pairs in each. The interambulacra are of unequal width; on the dorsal surface they are on a level with the ambulacra, but on the ventral surface they form nodulose eminences between them—so much so, that the ventral is as remarkable for its undulations as the dorsal is for the smoothness of its surface; the single interambulacrum being prominent and gibbous superiorly, posteriorly and inferiorly, but especially so in the latter region. The apical disc is a very curious structure, and is formed of two pairs of perforated oval plates, disposed in pairs, at some distance apart, and separated by three largely developed ocular plates which extend into the centre of the disc; the anterior pair of ovarials are of an irregular form, and separate the single ambulacrum from the antero-

lateral ambulacra ; on the surface of the right plate is placed the madreporiform body ; behind and between them is a small diamond-shaped plate occupying the median line, its anterior angle uniting with the apex of the single ambulacrum, and its posterior border with the anterior ovarials ; behind these are two rhomboidal-shaped plates, which articulate before with the anterior ovarials, laterally with the apices of the antero-lateral ambulacra, and behind with the posterior pair of ovarian plates ; near the points of junction of these plates with the ambulacra, the small eye-holes are situated ; behind the rhomboidal ocular plates, the small oblong posterior ovarian plates are situated. I can detect no ocular plates at the summits of the posterior ambulacra ; a fact, which in some measure serves to account for the concentration of the formative power on the three anterior ocular plates which exhibit such a disproportionate development in the apical disc of *Dysaster*. As this structure has not been accurately described by former observers, I have taken advantage of the circumstance of having before me a specimen most favourable for this purpose, and which I have carefully examined with the microscope under an inch object-glass.

The mouth is more or less subcentral, and lodged in a concavity ; it is of a pentagonal form, and is about one-eighth of the length of the shell. The surface of the test is covered with small tubercles having punctated summits, and surrounded by a circular depression ; they are larger on the ventral than on the dorsal surface, but are microscopic on both, and the intermediate surface of the plates is minutely granulated.

Affinities and differences.—Many of our specimens of this Urchin agree with the figures of *D. Eudesii* in M. Desor's monograph, whilst others have the depressed dorsal surface and angular outline of *D. ringens*, and as we have a series of intermediate forms connecting the extremes, it is probable that the former may only be a variety of the latter species. On this subject M. Cotteau* observes, that he collected with M. Moreau, from the "Oolite ferrugineuse" of Tour du Pré, a suite of specimens of *D. ringens* presenting various degrees of tumidity and more or less circularity of outline, and among which were all the gradations conducting to *D. Eudesii*, from which he concluded that the individual figured in his monograph, and which may be taken as a fair representation of many of our specimens, is a small and more elongated variety of *D. ringens*. This conclusion, according to Prof. Forbes†, is in accordance with the experience of the officers of the Geological Survey.

* Etudes des Echinides Foss. p. 48.

† Mem. Geol. Surv. Decade iii. pl. 9.

Locality and stratigraphical range.—*Dysaster ringens* var. *Eudesii* has been collected in the sands of the Inferior Oolite in Somerset and Dorset. Our specimens are from between Sherborne and Yeovil, Barton-Bradstock, Bridport, and Chideock Hill. On the continent it has been found in the "*Marnes Vésubiennes*" of the Jura by Agassiz, in the ferruginous Oolite of Normandy by Deslongchamps, and in the same stratum at Tour du Pré by Cotteau. Prof. M'Coy states that it is not uncommon in the Inferior Oolite of Leckhampton; but this is a mistake, as it is not within the experience of any of the local collectors, that a *Dysaster* was ever found in that locality; it is said however to occur in the Cornbrash near Cirencester, but we have not seen the specimens.

History.—*Dysaster ringens* was recorded for the first time by Agassiz in his 'Prodrome*', and has been successively figured and described in his 'Echin. Foss.,' by M. Desor in his 'Monogr. des Dysaster,' by Prof. Forbes in his 'Memoirs of the Geological Survey,' by M. Cotteau in his 'Etudes des Echinides,' and was mentioned by Desmoulins under the name of *Collyrites ringens*.

Dysaster bicordatus, Desor.

SYN. *Dysaster bicordatus*, Desor, Monogr. des Dysaster, p. 9. tab. 2. fig. 1-4; Agassiz and Desor, Cat. raisonné des Echin., A. S. N. tom. viii. p. 31.

Dysaster symmetricus, M'Coy, Annals of Nat. Hist. vol. ii. p. 414, 2nd Series.

— *Robinaldinus*, Cotteau, Etudes des Echinides, p. 75. tab. 7. fig. 1, 5.

Test thin, oval, anterior and posterior borders nearly uniform in convexity; sides tumid; dorsal surface convex, sometimes flattened; vertex excentral, situated near the anterior third; anus supra-marginal, postero-lateral ambulacra forming an arch over the anal opening; base convex, without undulations; mouth-opening small, situated at about the junction of the anterior with the middle third of the base.

Height at vertex $\frac{1}{2}\frac{5}{8}$ ths of an inch, antero-posterior diameter 1 inch, transverse diameter $\frac{9}{10}$ ths of an inch.

Description.—The regular oval outline of this *Dysaster* forms a contrast to the orbicular and subpentagonal figure of *D. ringens* var. *Eudesii*; the sides are tumid, the dorsal and basal surfaces are smooth and convex, and the test has a uniformly gibbous appearance; the ambulacra are all complete, passing from the mouth to their terminations on the dorsal surface without inter-

* Mém. de la Soc. d'Hist. nat. de Neuchâtel.

ruption, and both on the dorsal and ventral surfaces being on a level with the interambulacral aræ; the three anterior ambulacra converge about the anterior third of the back; the apex of the single anterior area is separated from those of the antero-laterals by the anterior pair of ovarian plates; the single ambulacrum is the narrowest, and the postero-lateral ambulacra are the widest; the anterior border is slightly flattened, and in the centre of this space the single ambulacrum passes in a straight line from the vertex to the mouth; at the apex of this area there is a small prominent subtriangular eminence which forms the highest point of the test, so that in this species the vertex is situated at the anterior third of the back, whilst in *D. ringens* it is in the posterior third; the antero-lateral ambulacra curve gently upwards, backwards and forwards from the mouth to the apical disc, forming thereby a gently undulated line; the postero-lateral ambulacra take a long sinuous course from the mouth, passing backwards, outwards and upwards over the posterior border, and converging near the median line above the anal opening, over which they form an arch; the apices of the postero-lateral ambulacra converge on the back at the distance of $\frac{2}{5}$ ths of an inch behind the antero-lateral ambulacra; the pores are placed in oblique pairs, and are very distinct on the sides and back, but on the ventral surface they are small and very indistinct; in the specimens before me the interambulacral plates are large and bent, each forming a double inclined plane; the aræ are uniformly smooth and gibbous, the single interambulacrum is obliquely bevelled and slightly flattened, and at the extreme upper part of this area, nearly on a level with the dorsal surface, the anus is lodged; the opening has a pyriform shape with the apex directed upwards, from its lateral walls two obtuse ridges pass downwards and outwards; the basal portion of this area is a little more gibbous and produced than the other area. The ventral surface is convex with scarcely any undulation, anteriorly there is a slight concavity, and posteriorly an increased convexity occasioned by the gibbosity of the single interambulacrum; the mouth is lodged in a slight depression, the opening is small and subpentagonal, and is situated about the anterior fourth part of the antero-posterior diameter of the test; the exact relative situation of this aperture appears to vary in the different individuals I have measured. The apical disc is situated behind the subtriangular apical eminence, and therefore occupies the anterior third of the back; it has a lengthened rhomboidal figure and is formed very much like the disc in *D. ringens*, of which we have already given a detailed description; the four perforated ovarian plates and the three large curiously implanted ocular plates are seen very distinctly in the specimen before me; the

right ovarian plate supports the madreporiform body. The elements of the disc are in general so entirely united with the adjoining pieces of the shell, that it is only in weathered specimens, or in those where the test has passed into the condition of calcareous spar, that we can distinguish the separate pieces of which it is formed. The surface of the shell is covered with small tubercles surrounded by circular depressions, between which numerous microscopic granules are scattered; the spines are unknown.

Affinities and differences.—In its general outline *D. bicordatus* resembles *D. ringens*, but is distinguished from it by the following characters: in *D. bicordatus* the highest point of the back is near the anterior third, whilst in *D. ringens* it is at the posterior third; in *D. bicordatus* the ventral surface is nearly uniformly convex, in *D. ringens* it is very much undulated; in *D. bicordatus* the apical disc is situated near the anterior third of the dorsal surface, whilst in *D. ringens* it is nearly central; the single interambulacrum is not so much developed, the anal opening is larger and higher up, and the anal valley is more rudimentary in *D. bicordatus* than in *D. ringens*. By its height and dimensions and the disposition of the ambulacra, and the high position of the anus and rudimentary valley, *D. bicordatus* closely resembles *D. Robinaldinus*. M. Cotteau however thinks it is distinct; but we have before us specimens from the Inferior Oolite so closely resembling the figure given by him in his 'Etudes des Echinides,' that we suspect Cotteau's species to be a variety of *D. bicordatus*. We have before remarked, that in our opinion a greater or less elevation of the dorsal surface or a flattening of the borders of the test do not *per se* constitute specific characters; for this reason we consider *D. symmetricus* as only an oval variety of *D. bicordatus*.

Locality and stratigraphical range.—This species has been collected with *D. ringens* by the officers of the Geological Survey from the sands of the Inferior Oolite of Dorsetshire. I have never had the good fortune to find it in the same stratum in Gloucestershire; it may however occur at Frocester and Wootton-under-Edge, where the sands of the Inferior Oolite attain a great development.

History.—First figured and described by Desor in his 'Monogr. des Dysaster,' afterwards by Cotteau under the name *D. Robinaldinus* in his 'Etudes des Echinides Fossiles,' and described under the name *D. symmetricus* by Prof. M'Coy; recorded as occurring in abundance in the Inferior Oolites of Dorsetshire by the officers of the Geological Survey.

Dysaster ovalis, Agass.

SYN. *Dysaster ovalis*, Agassiz, Cat. Syst. 3; Desor, Monogr. des Dysaster, p. 15. tab. 3. fig. 21-23; Agassiz and Desor's Catalogue raisonné des Echinides, A. S. N. tom. viii. p. 32.

Spatangus ovalis, Parkinson, Org. Rem. vol. iii. tab. 3. fig. 3; Phillips, Geol. of Yorksh. vol. i. p. 127. tab. 4. fig. 23; Young and Bird, Geol. of York. pl. 6. fig. 9.

Var. A. *Dysaster propinquus*, Agass. Echin. Foss. Suisse, i. p. 2. tab. 1. fig. 1-3; Desor, Monogr. des Dysaster, p. 14. tab. 3. fig. 24-26; Agassiz and Desor's Catalogue raisonné des Echinides, p. 32.

Var. B. *Dysaster truncatus*, Dubois, Voy. au Cauc. (Ser. Geol.) tab. 1. fig. 1; Desor, Monogr. des Dysaster, p. 17. tab. 13, des Galerites, fig. 8-11; Agassiz and Desor, Cat. raisonné des Echinides, p. 32.

Var. *major*. Height $\frac{1}{2}\frac{8}{10}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{1}{10}$ ths, transverse diameter 1 inch and $\frac{1}{10}$ ths.

Var. *minor*. Height $\frac{1}{2}\frac{5}{10}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{1}{10}$ ths, transverse diameter $\frac{1}{2}\frac{8}{10}$ ths of an inch.

Description.—The general outline of this *Dysaster* is oval, the anterior border however forms the segment of a larger circle than the posterior border, which is produced and truncated; the upper surface is uniformly convex, the sides are tumid, and the base is flat; the ambulacral aræ are relatively wide, the anterior single ambulacrum and the antero-lateral ambulacral aræ converge at the apical disc, near the centre of the back; the single area descends in a depression which grooves the anterior border of the test, and the base thereof as far as the mouth; the antero-lateral ambulacra are gently sinuous, and form graceful curves over the sides of the shell, having their apices separated from that of the single area by the anterior pair of ovarian plates; the postero-lateral ambulacra are relatively wider than the antero-laterals, they take a straight direction at the base, are slightly sinuous on the sides, and converge at about the posterior third of the back, at a point about midway between the apical disc and the anal opening. The interambulacral aræ are formed of large plates, the single area is produced and sometimes truncated, and the anal opening is situated at the superior part of the posterior border between the point of convergence of the postero-lateral ambulacra and the basal angle.

The mouth-opening is excentral and lodged in a depression near the anterior border, about the anterior fourth of the base; the surface of the shell is covered with small tubercles, very uniform in size on the different parts thereof; the interambulacral plates are convex inferiorly and concave superiorly, whilst the ambulacral plates are united together by straight sutures; the

pores are small and distinct, and more numerous in the avenues than in the preceding species; the apical disc is formed of four ovarian plates and three large ocular plates, the mode of arrangement appearing to resemble that described in *D. ringens*, but we cannot state precisely their structure from the condition of the test.

M. Cotteau observes that *D. ovalis* has been collected in the two divisions of the Oxfordian stage (département de l'Yonne), and in each it presents a distinct variety. In the ferruginous beds which repose upon the upper layers of the Bathonian stage it is of small size, and is flattened before, contracted behind, and almost flat above; in the Oxfordian limestones or upper division of this stage it is much larger in size, of a regular oval form, with more tumid sides: both of these varieties are figured in his work*.

Affinities and differences.—Adopting as we do the careful observations made by Agassiz and Desor on this species, who regard *D. propinquus* and *D. truncatus* as varieties of *D. ovalis*, these forms are readily distinguished from their congeners by the uniformly tumid oval form of the test. The large variety of *D. ovalis* however much resembles *D. analis*, but the former is distinguished from the latter species by the structure of the ambulacra; in *D. analis* the postero-lateral areæ converge immediately above the anal opening, whilst in *D. ovalis* their point of convergence is at some distance before that opening.

Locality and stratigraphical range.—This species was obtained by the Rev. Mr. Young† and by Mr. Phillips‡ from the calcareous grit, and by the latter from the Coralline Oolite and Kelloway rock of Yorkshire. Its foreign distribution, according to Agassiz and Desor's Catalogue§, is from the "Argovien du Fringeli, Liesberg, Largue, Walen, D'Elemon, Purrentruy, Palins, Mont Brégille, near Besançon." It has been collected from the two divisions of the Oxfordian stage by M. Rashier, from the ferruginous beds at Gigny, and from the calcareous beds at Villiers-Hauts, département de l'Yonne||.

History.—Our table of synonyms, to which we refer, gives the history of this species; it has been figured as a British Urchin by Parkinson, Young and Bird, and Phillips, in their respective works, but in all so badly that their figures are worthless; Agassiz

* Etudes des Echinides, p. 87.

† Geological Survey of the Yorkshire Coast, p. 215.

‡ Geology of Yorkshire, p. 134.

§ Annales des Sciences Naturelles, tom. viii. p. 32.

|| Cotteau, Echin. Foss. p. 87.

has given beautiful drawings of the Swiss variety, and Cotteau indifferent ones of the larger and smaller varieties occurring in France.

Dysaster analis, Agass.

SYN. *Dysaster analis*, Agass. Prodrôme Mem. Neuch. vol. i.

Collyrites analis, Desmoulins, Tab. Synop. p. 368. no. 14.

Dysaster analis, Agass. Echin. Suisse, i. p. 6. tab. 1. fig. 12-14;

Gressly, Jur. Sol. p. 76; Desor, Monogr. des *Dysaster*, p. 10.

tab. 2. fig. 8-10; Agassiz and Desor, Cat. raisonné des Echinides, p. 32.

Test suborbicular, inclining to oval, more or less depressed, round and inflated anteriorly, slightly contracted posteriorly; dorsal surface convex, more declined from the vertex to the anus than from the vertex to the anterior border; anterior half forming the segment of a larger circle than the posterior half; vertex excentral; apical disc nearly central, at which the single ambulacrum and the antero-lateral ambulacra converge; the postero-lateral ambulacra meet at the distance of $\frac{7}{10}$ ths of an inch behind the antero-laterals; anus nearly circular and prominent, situated in the middle of the posterior border about midway between the ambulacral arch and the basal angle; ventral surface flat, without undulations; mouth circular, situated in a depression about the junction of the anterior with the middle third of the ventral diameter; sides convex, suddenly declining from a slight median elevation.

Height 1 inch, antero-posterior diameter 1 inch and $\frac{2}{10}$ ths, transverse diameter 1 inch and $\frac{7}{10}$ ths.

Description.—The nearly ovato-orbicular circumference and depression of the dorsal surface, which is not uniformly convex, with the flatness of the ventral surface, form a group of characters by which this *Dysaster* is distinguished from its congeners. The anterior half of the body is fuller and more developed, and forms the segment of a larger circle than the posterior half.

The single ambulacrum, which is lodged in a slight depression on the anterior border, is wider than the others; the antero-lateral ambulacra form graceful curves on the anterior sides of the shell, and with the single ambulacrum converge at the apical disc; the postero-lateral ambulacra are situated very far back, and occupy the posterior sixth of the antero-posterior diameter of the test; they converge at some distance above the anus at a point situated $\frac{7}{10}$ ths of an inch behind the apical disc; a very large intermediate space is thereby formed for the development of the posterior pair of interambulacra, the converging point of the antero-lateral and postero-lateral ambulacra being

proportionally further removed in this species than in its congeners. The interambulacral areas are of unequal width, the anterior pair are the narrowest, the posterior pair are the widest, and the single interambulacrum is of intermediate dimensions; the anterior pair are convex and prominent, and give the front of the shell an inflated appearance; the posterior pair gradually decline towards the anus and the lateral borders, and form a broad saddle which extends across the back and sides of the test. The single interambulacrum is small, and destitute of the basal development so characteristic of the analogous area in *D. ringens* and *D. bicordatus*.

The dorsal surface is not uniformly convex; the anterior half is rounder and more inflated than the posterior half; the latter is more depressed on the back and more contracted on the sides than the anterior half, and forms the segment of a much smaller circle than it; the vertex is excentral and situated nearer the anterior than the posterior border, corresponding to about the apex of the single ambulacrum; the apical disc is nearly central, but its structure is not preserved in the specimen before me; according to Agassiz, the holes in the four ovarian plates are very small, and their position is not regular; in general, the one corresponding to the right posterior interambulacral area is behind that of the left side.

The anal opening is situated in the posterior border about midway between the arch formed by the postero-lateral ambulacra and the angle of the shell; the aperture is large, prominent, and of an elliptical or nearly circular form; the ventral surface is flat, and in this respect presents a striking contrast to its congeners. In some of the best preserved specimens, the subanal prominence formed by the interambulacrum, and which is so prominent in *D. ringens*, is absent in *D. analis*. The mouth-opening, of a circular form, is situated in a slight depression near the anterior border, at the junction of the anterior with the middle third of the base. It has been remarked by Agassiz, who had the advantage of examining a suite of perfect specimens of this species from the Inferior Oolite of Switzerland, that the ambulacral plates diminish sensibly in depth when traced from the mouth to the points of convergence of the ambulacra; as each plate corresponds to a pair of pores, it follows that these are much more closely set together on the dorsal than on the ventral surface; the interambulacral areas are very large; the plates have a crescentic form, the lower border being convex, and the upper border more or less concave; by reason of the great distance between the antero-lateral and postero-lateral ambulacra, the plates forming the posterior pair of interambulacral areas are much

larger on the dorsal surface of the shell than their analogues of the anterior interambulacra. The tubercles are very uniformly distributed upon the surface of the test, but are more numerous upon the inferior than the superior surface. The epiderm which covered the whole presented a finely granular aspect*.

Affinities and differences.—This Urchin resembles *D. ovalis*, but is distinguished from it by the unequal convexity of the dorsal surface, the flatness of the base, and the greater proportional distance between the points of convergence of the antero-lateral and the postero-lateral ambulacra; the form and structure of the areæ are likewise different; in fact these characters form a good diagnosis between *D. analis* and its congeners. Moreover *D. analis* is found only in the Inferior Oolite, and *D. ovalis* is limited to the Coralline Oolites.

Locality and stratigraphical range.—The imperfect specimen before me was obtained from the ferruginous beds of the Inferior Oolite at Dundry; it belongs to the Bristol Institution, and I am indebted to the kindness of my friend Mr. Etheridge, the Curator, for permission to describe the same. This species was found by MM. Gressly, Hugi and Stromeyer in the Inferior Oolite of Goldenthal and Fringeli (canton de Soleure†), and in the Marn. vésul. (Inferior Oolite) of Wallenburg, Egg et Burg (Argovie), le Mont-Terrible, Saint Maixant, by Broun, Thurmann and D'Orbigny‡.

History.—Figured and described for the first time by Agassiz in his 'Echinodermes Fossiles' from specimens collected in the Canton of Soleure, and subsequently by the authors cited in our synonyma of this species, and now identified as a British Urchin for the first time. *D. analis* must be rare, as the specimen before me is the only one I have met with in all the collections I have examined with the view of ascertaining the species of Echinoderms contained in our Oolitic system.

2. GROUP OF NUCLEOLIDES §.

Ambulacra petaloid; mouth subcentral, margin sometimes surrounded with prominent lobes.

* Echinodermes Foss. de la Suisse, 1st Part, p. 7.

† Agass. Echinoderm. Foss. p. 6.

‡ Annal. des Sciences Nat. tom. viii. p. 32.

§ The group of Nucleolides comprehends eleven genera: *Nucleolites*, Lam.; *Cassidulus*, Lam.; *Catopygus*, Agass.; *Pygaulus*, Agass.; *Archiacia*, Agass.; *Pygorhynchus*, Agass.; *Pygurus*, Agass.; *Echinolampas*, Gray; *Amblypygus*, Agass.; *Conoclypeus*, Agass.; *Asterostoma*, Agass.

Genus NUCLEOLITES, Lamarck.

Test oval, cordate, or orbicular, more or less tumid, sometimes much depressed; covered with small imperforate tubercles, surrounded by a circular depression; ambulacra petaloid on the dorsal surface, forming straight narrow valleys on the base; pores widely separate and united by transverse delicate lines above, and placed close together in pairs, which are more widely apart at the base; mouth-opening subcentral, more or less pentagonal, with or without marginal folds; anal opening supra-marginal, situated in a valley more or less deep formed by the single interambulacral area, commencing near or at a short distance from the apical disc; vertex always excentral; apical disc situated near the vertex, and formed of two pairs of perforated ovarian plates, and a single imperforate plate composed of one or more pieces, having the spongy body attached to its surface, and five small ocular plates arranged around the angles of the ovarials.

Nucleolites clunicularis, Llhwyd.

SYN. *Nucleolites scutata*, Lam. Animaux s. Vert. tome iii. p. 36.

Nucleolites clunicularis, Bronn, Lethæa Geognost. p. 282.

— *scutatus*, Agass. Echinoderm. Foss. Suisse, t. vii. fig. 19–21. p. 45.

— *depressa*, De Blainv. Zoophyt. p. 188.

Spatangus depressus, Leske, ap. Klein, tab. 51. fig. 1, 2. p. 238.

Clypeus clunicularis, Phillips, Geol. of Yorksh. Part 1. p. 115. pl. 7. fig. 2.

Echinites clunicularis, Llhwyd, Lith. Brit. Ichnogr. p. 48. No. 988.

Test subquadrate in circumference, anterior border rounded, posterior border bilobed; upper surface convex, declining abruptly anteriorly, and more gently posteriorly; vertex excentral, at which is situated the apical disc; ambulacra narrowly lanceolate above and converging below; anal furrow deep, lanceolate, and extending to the posterior border of the apical disc; posterior lobes gently tapering, not tumid; base concave and grooved by the five ambulacral valleys; mouth slightly pentagonal, and situated nearer the anterior than the posterior border.

Height $\frac{1}{2}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{3}{10}$ ths, transverse diameter 1 inch and $\frac{5}{10}$ ths (Inferior Oolite specimen).

Height $\frac{1}{4}$ ths, antero-posterior diameter 1 inch and $\frac{2}{10}$ ths, transverse diameter 1 inch and $\frac{1}{10}$ th (pyramidal variety from the Cornbrash).

Description.—This Urchin has been long known to naturalists,

and the list of synonyms shows some of the names under which it has been described; it presents many varieties of outline as well as of height, and these forms have sometimes been mistaken for and described as distinct species by different authors, so that much confusion has been made regarding its identity. The suite of specimens before me, from the Inferior Oolite, Great Oolite, and Cornbrash, vary from a suborbicular to a nearly quadrate outline, presenting all the intermediate forms: they are rounded anteriorly, a little contracted before, slightly swelled out at the sides, and more or less bilobed posteriorly. The dorsal surface is convex, exhibiting various degrees of elevation; in some it is much depressed, in others elevated into a subconical form. In the ten specimens before me, there are not two that have the same proportional height. The vertex is almost always excentrical, and inclined towards the anterior border, but the amount of this inclination, like the height, varies in different individuals: in a beautifully perfect specimen from the Cornbrash the vertex is quite central. The ambulacral areas have a petaloid or lanceolate form with nearly parallel sides, the single area and the anterior pair are nearly of the same length and width, and the posterior pair are the longest and widest. The pores on the upper two-thirds of the dorsal surface are situated at some distance apart, and are united by fine sutures; at the inferior third of the area they approximate and pass from thence round the basal angle to the mouth; on the under surface the pores are very small and indistinct and set widely apart. The interambulacral areas are of unequal width, the posterior pair are nearly one-fourth wider than the anterior pair, and the single area is the widest. The anal valley extends from the disc to the basal angle; it is of a lanceolate form with vertical parallel walls, which gradually diverge and then approximate, and afterwards expand outwards, forming a well-defined groove; the round anal opening is perforated at the extreme end of the valley; the whole surface of the test is covered with small close-set tubercles, surrounded by circular depressions, and having the interspaces minutely granulated; those on the dorsal surface are quite microscopic, whilst those on the base are larger and better defined. The apical disc is formed of two pairs of perforated ovarian plates, and a single imperforate plate with a central element having a spongy body attached to its surface, around which the five ovarian plates are arranged; the ocular plates are lodged at the apices of the ambulacra, at which point the eyeholes are seen sometimes drilled in the border of the plates, sometimes formed between the ocular plates and the apices of the ambulacra. The surface of the ovarian and ocular plates is covered with microscopic granules.

The base is more or less concave, most so in the pyramidal varieties, and is slightly undulated; the ambulacra radiate in straight lines from the mouth, and the interambulacra form slightly convex pyramids between them. The mouth-opening is excentrical and situated in a deep depression nearer the anterior than the posterior border.

Affinities and differences.—This species very much resembles *N. dimidiatus*, but is distinguished from that species by its tapering posterior lobes, which are more tumid in *N. dimidiatus*, by the extent of the anal valley, which in *N. clunicularis* extends from the disc to the margin, whilst in *N. dimidiatus* there is a smooth portion of the test between the disc and the commencement of the valley: from *N. orbicularis* this species is distinguished by its subquadrate form, increasing sides, and bilobed posterior extremity; it wants likewise the general tumidity so characteristic of *N. orbicularis*, which it resembles in the length of the anal valley.

Locality and stratigraphical range.—We have collected this Nucleolite from the upper ragstones of the Inferior Oolite of Rodborough, Coopers, Birdlip, and Leckhampton Hills; it is not however a common species. It is found in the Great Oolite at Minchinhampton and Cirencester, in the Cornbrash of Gloucestershire, Wiltshire, Northamptonshire, and Yorkshire: the Inferior Oolite specimens are the most orbicular and depressed, the Great Oolite ones are the smallest, and the Cornbrash are the most pyramidal in form.

Its foreign distribution, according to Agassiz and Desor*, is "Oxford d'Alençon, Courgains (Sarthe), Calc. à Polypiers de Ranville, Coulie. Var. *minor*. Forest marble de Châtellensoir." Form *latiporus*, "Cornbrash de Meltingen (Cant. de Soleure), Maiche (Doubs). Form *gracilis*, Ool. Ferrug. de Dürrenast (Jura Soleurois)."

History.—It would carry us far beyond our limits to attempt to trace the history of this species from Llhwyd to Agassiz; but even had it been otherwise it would have been unnecessary, as this has been so ably done by Professor Forbes in his 'Memoirs of the Geological Survey,' to the 1st Decade of which the reader is referred for an excellent critical examination of the literature of this species; in the same work it is most elaborately figured and correctly described.

* Catalogue raisonné des Echinides: Annales des Sciences Naturelles, tome vii. p. 153, 3^e série.

Nucleolites dimidiatus, Phillips.

SYN. *Nucleolites dimidiatus*, Phillips, Geol. of Yorksh. vol. i. pl. 3. fig. 16; Forbes, Memoir of Geol. Survey, Decade 3. description of pl. 9; Agassiz and Desor, Cat. raisonné des Echinides. *Nucleolites paraplesius*, Agassiz, Catalogue Syst. p. 4.

Test ovate or subquadrate, compressed at the sides, rounded anteriorly, expanded and bilobed posteriorly, dorsal surface convex; apical disc central, vertex excentral, anterior and lateral border and posterior lobes tumid; ambulacra narrow and lanceolate; anal valley deep, ovate or obtusely lanceolate, extending about two-thirds of the space between the border and the vertex, and terminating at a distance from the disc; base concave, much depressed at the mouth-opening, which is pentagonal and excentral.

Height $\frac{6}{10}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{3}{10}$ ths, transverse diameter 1 inch and $\frac{1}{10}$ th.

Description.—This species was formerly considered a variety of *N. chunicularis*, but was correctly separated from that form by Mr. Phillips. It does not appear to deviate so much from its typical outline as that species; the greater fullness of the sides, the tumidity of the posterior lobes, and the shortness of the anal valley are characters which are very uniformly preserved in the individuals now before me. The single and the anterior pair of ambulacra are narrower than the posterior pair, they have a lanceolate form, rather obtuse at the apex; the pores are set at short distances apart; on the dorsal surface they become approximated near the margin, and pass from thence to the mouth in pairs, set however more widely apart at the base. The interambulacra are of unequal width, the posterior pair are nearly one-third wider than the anterior pair; the single area has a cordate form from the development of the posterior lobes, and equals in width that of the posterior arææ. The anal valley forms one of the distinctive characters of this species; it is of an ovate or lanceolate form with a blunt apex, and in some individuals it has the appearance of a portion of the test having been drilled out of the single area; in some specimens it extends only half the distance between the margin and the vertex, whilst in others it reaches two-thirds that length, but in all the individuals before me there is an undepressed portion of the test separating the apical disc from the superior border of the anus; inferiorly the valley forms a considerable sulcus, which grooves the centre of the single area, dividing its posterior border, and producing the cordate bilobed form it assumes; the surface of the test is irregularly covered with small tubercles, which are of microscopic minuteness above,

but are larger below, and are surrounded by a circular depression; the vertex is excentral, behind which the apical disc is situated; it is nearly central in some individuals, and quite so in others, and is formed of two pairs of perforated ovarial plates, and a single imperforate plate; the madreporiform body occupying the centre of the disc, and the five small ocular plates are seen at the apices of the ambulacra. The base is more or less concave, and deeply so at the point where the mouth-opening is placed; this aperture has a pentagonal form, and is much nearer the anterior than the posterior border. The ambulacra form valleys that are scarcely perceptible in passing from the border to the mouth.

Affinities and differences.—In its general outline *N. dimidiatus* resembles *N. clunicularis*, but is distinguished from that species by its ovate anal valley, which extends only two-thirds of the length of the dorsal surface of the single interambulacrum, whereas in *N. clunicularis* it reaches from the apical disc to the margin; the tumidity of the sides and posterior lobes afford additional diagnostic characters. It is so entirely distinct from the other Oolitic congeneric forms, that it cannot be mistaken for either of them.

Locality and stratigraphical range.—This species has been collected from the Coralline Oolite of Calne and Steeple Ashton, Wilts, and of Malton and Filey Bridge, Yorkshire; it is found likewise in the same stage in Oxfordshire and near Havre.

History.—First figured as a species distinct from *N. clunicularis* by Mr. Phillips in his 'Geology of Yorkshire,' and now described in detail for the first time.

Nucleolites orbicularis, Forbes.

SYN. Clypeus orbicularis, Phillips, Geol. of Yorksh. vol. i. pl. 7. fig. 3.
Nucleolites orbicularis, Forbes, Mem. of Geol. Survey, Decade 1. description of pl. 7.

Test orbicular, dorsal surface irregularly convex and depressed; sides tumid; vertex and apical disc central; ambulacra lanceolate; anal valley narrow, extending from the disc to the border; posterior lobes obsolete; base flat, slightly concave; mouth subcentral, situated in a depression.

Height $\frac{6}{10}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{1}{10}$ th, transverse diameter 1 inch and $\frac{5}{10}$ ths. One large specimen is $1\frac{1}{2}$ inch in diameter, but its proportional dimensions cannot be ascertained, as it is crushed.

Description.—The orbicular circumference, tumid sides, obsolete lobes, and broad, flat, and somewhat irregular dorsal surface

distinguish *N. orbicularis* from its congeners. The ambulacra are nearly all of the same width; they have a more petaloid form than in the preceding species, in consequence of the pores being set farther apart and connected by deeper sulci; near the margin of the test the pores become very small and approximated, on the base they are very indistinct and more widely apart, and continue so to the mouth. The interambulacra are unequal, but less so than in *N. chuncularis* and *N. dimidiatus*, and the single area is the widest. The test is covered with microscopic tubercles; so minute in fact are they, that without the aid of a good lens the surface appears quite smooth. The anal valley is narrow, and extends from the vertex to the margin. The base is concave and slightly undulated from the convexity of the interambulacra and the straightness of the ambulacra. The mouth is excentral and slightly five-lobed. The apical disc is broad, and formed of two pairs of large perforated and a single imperforate ovarian plate, having the madreporiform element occupying the centre thereof; the size of the ovarian plates occasions a greater distance between the ocular plates, which are consequently more apart than in the other species. The test is very thin, and the spines, which are preserved in one individual, are moderately long and needle-shaped.

Affinities and differences.—The orbicular form and long anal valley liken *N. orbicularis* to some individuals of *N. sinuatus*; from them however it is distinguished by the tumidity of the sides and flatness of the dorsal surface; it is known from *N. Hugii* by the anal valley extending from the disc to the margin, whereas in the latter species the upper anal border is separated from the vertex by an undepressed portion of the shell; from the other *Nucleolites* of our Oolites it is very distinct.

Locality and stratigraphical range.—It is found in the Inferior Oolite of Rodborough Hill, the Great Oolite of Minchinhampton, and Salperton Tunnel, Great Western Railway, and the Coralline Oolite of Calne, Wilts. Mr. Phillips's specimens were collected from the Cornbrash near Scarborough; it has likewise been found at Wollaston near Wellingborough, Northamptonshire.

History.—Figured by Mr. Phillips in his 'Geology of Yorkshire,' but not described in that work; enumerated by Professor Forbes in his note on "British *Nucleolites*" appended to the description of the 9th plate of his 1st Decade*, and now described in detail for the first time.

* Mem. of the Geol. Survey of Great Britain.

Nucleolites Hugii, Forbes.

SYN. *Clypeus Hugii*, Agassiz, Echin. Foss. Suisse, vol. i. p. 37. tab. 10. fig. 2-4.

Nucleolites Hugii, Forbes, Mem. Geol. Surv. Decade 1. description of pl. 9.

Test suborbicular, dorsal surface convex and depressed; apical disc and vertex subexcentral; ambulacra lanceolate, apices approximated; anal valley oblong, obtuse and short, separated from the vertex by a considerable portion of undepressed test; single interambulacrum produced and much deflected; posterior lobes small; base concave and undulated; mouth much excentral near the anterior border; of a pentagonal form and surrounded by five lobes.

Height $\frac{1}{8}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{1}{10}$ ths, transverse diameter the same as the antero-posterior.

Description.—This is a very distinct form of *Nucleolite*; the circumference is suborbicular, sometimes a little compressed at the sides; the dorsal surface is convex, and the antero-posterior exceeds the transverse diameter in some, and these diameters are nearly equal in other individuals. The ambulacra have a lanceolate form; the single ambulacrum and the anterior pair are nearly the same width, and the posterior pair are the widest; their apices approximate very closely in consequence of the smallness of the apical disc. The pores are not far apart on the dorsal surface; the internal row consists of small round holes, the external row are somewhat elongated transversely, and unite with the internal row by a delicate suture; near the border they approximate and are disposed in close-set pairs. As we trace them from the basal angle to the mouth they lie widely apart, but near the mouth they become again more closely approximated, and fall into triple oblique pairs as in *Echinus* and *Pedina*. The anterior pair of interambulacra are the narrowest, the single interambulacrum is the widest, and the posterior pair are of intermediate dimensions; the anterior border is obtusely rounded, the sides swell gradually outwards to the junction of the posterior pair with the single area, which is the widest part of the test; the single interambulacrum is slightly produced and much deflected; the anal valley is short and oblong, with an obtuse upper margin, which does not extend one half the distance between the border and the vertex, the space between the anal margin and the vertex being occupied by a smooth undepressed portion of the test: this character allies *N. Hugii* to *N. dimidiatus*; but the orbicular outline, the greater size, and the produced and deflected single interambulacrum of the former constitute a group of characters by which it is readily distinguished from the latter

species. The base is concave and undulated, the ambulacra forming straight valleys, and the interambulacra more convex elevations than in any other of its congeners. The mouth is very excentral, being situated near the junction of the anterior with the middle third of the basal antero-posterior diameter; the opening has a pentagonal form, and is surrounded with five small lobes. The apical disc occupies the vertex, which is slightly excentral, inclining towards the posterior border; it is formed of two anterior and two posterior perforated ovarian plates with a single imperforate plate and a spongy madreporiform body occupying the centre; the ocular plates are small, and the orbits appear to be formed by the apices of the ambulacra and the margin of the ocular plates. The test is moderately thick, its surface is closely covered with small tubercles surrounded by a circular depression, and the intertubercular spaces are delicately sculptured with microscopic granules; the tubercles on the dorsal surface are much smaller than those on the base.

Affinities and differences.—This species resembles *N. orbicularis* in its suborbicular form, but is readily distinguished from that species by its declining sides and the absence of the general tumidity so characteristic of *N. orbicularis*; the form and structure of the anal valley are likewise different; in *N. orbicularis* it extends from the margin to the apical disc, whilst in *N. Hugii* it occupies only the inferior half of the single interambulacrum; that area is likewise more produced and much deflected in *N. Hugii*. From *N. dimidiatus*, *N. Hugii* is readily distinguished by the inferior position of the anal opening, the deflected lip-like form of the single interambulacrum, and the rudimentary condition of the posterior lobes; the size and suborbicular outline of *N. Hugii* form likewise a strong contrast to the small oblong form of *N. dimidiatus*.

Locality and stratigraphical range.—I have collected *N. Hugii* from the Inferior Oolite of Rodborough Hill, and a mutilated specimen from the upper ragstones of Leckhampton Hill; it is therefore a rare Urchin in Gloucestershire. Its foreign distribution, according to Agassiz, is Inferior Oolite du Jura Soleurois et Evêché de Bâle, le Mont-Terrible (Cant. de Berne). As far as I can learn, it has hitherto been found only in the Inferior Oolite.

History.—First figured and described by Agassiz in his 'Echinodermes Fossiles de la Suisse,' identified in the British Museum collection as a British Urchin by Mr. S. P. Woodward, enumerated in Prof. Forbes's note on "British *Nucleolites*," and now described in detail as such for the first time.

Nucleolites Solodurinus, Wright.

SYN. *Clypeus Solodurinus*, Agassiz, Echin. Foss. Suisse, vol. i. p. 35. tab. 5. fig. 1-3.

Test oblong, posterior border much produced, deflected and truncated; ambulacra petaloid, apices approximated; vertex and apical disc excentral, inclined towards the posterior border; anal valley narrow, acutely lanceolate, extending from the vertex to the posterior border; base concave; mouth excentral, surrounded by five well-developed lobes.

Height $\frac{1}{2}$ ths of an inch, antero-posterior diameter 2 inches, transverse diameter 1 inch and $\frac{8}{10}$ ths.

Description.—This Urchin is distinguished from its congeners by its oval circumference, depressed dorsal surface, and produced and truncated posterior border. The ambulacral areas are formed of very narrow plates, have a regular acutely lanceolate or petaloidal form, a nearly uniform width and closely approximated apices; and the pores are placed further apart, and connected by finer and more close-set sulci than in *N. Hugii*, which gives more breadth to these divisions of the test; above the marginal angle the pores approximate, on the base they are wide apart, but within a short distance, about 4 lines, from the mouth they become more numerous and form close-set triple oblique pairs. The interambulacra are of unequal width, the anterior pair are the narrowest, the posterior the widest, and the single interambulacrum about the same as the latter; this area is much produced, deflected, and abruptly truncated posteriorly; the anal valley is narrow, deep, and acutely lanceolate, extending from the apical disc to the border. The vertex is excentral and slightly inclined posteriorly; the apical disc is small and situated immediately behind the vertex; it is formed of an anterior pair and a posterior pair of oblong perforated ovarian plates, and a single imperforate ovarian plate, with a spongy madreporiform body occupying the centre of the disc. The ocular plates are small, and the eyeholes near the margins. The base is concave and undulated, the ambulacra forming straight valleys, and the interambulacra convex elevations between. The mouth is pentagonal and excentral; its margin is surrounded by five lobes, the terminal portions of the interambulacra, between which are notches formed by the contracted ambulacra, which are here freely perforated for the passage of tubular organs, which appear to have been very numerous around the mouth. The test is moderately thick; its surface is covered with small tubercles surrounded by circular depressions, as in the other species of this genus; the tubercles on the base are larger than those on the dorsal surface.

Affinities and differences.—*N. Solodurinus* more nearly resem-

bles *N. sinuatus* than any other species, having with it affinities in the form and structure of the ambulacra, the narrowness and extent of the anal valley, and the depression of its dorsal surface; it is distinguished however from *N. sinuatus* by its oblong circumference, produced single interambulacrum, which is more flattened, deflected, and abruptly truncated than in that species. The dorsal surface is likewise more depressed; in fact, the angular outline and produced and truncated posterior border separate *N. Solodurinus* from all its congeners.

Locality and stratigraphical range.—This is a rare species; it was collected by Mr. S. P. Woodward from the upper beds of the Inferior Oolite near Stroud, and to whom we are indebted for the loan of the specimen which has served for the foregoing description. We have a broken specimen from the same beds near Salperton Tunnel, Great Western Railway: in the Museum of Economic Geology there is a specimen from the Inferior Oolite of Dorsetshire. Its foreign distribution, according to Agassiz and Desor's 'Catalogue raisonné,' is "Marn. vésul. Obergoeschen (Jura Soleurois), Egg (Argovie), Poligny (Jura)."

History.—First figured and described by Agassiz in his 'Echinodermes Fossiles de la Suisse,' afterwards identified as a British fossil by Mr. S. P. Woodward, and now described as such for the first time.

Nucleolites sinuatus, Leske.

SYN. *Clypeus sinuatus*, Leske apud Klein, Echinod. p. 157. tab. 12;

Parkinson, Organic Remains, vol. iii. pl. 2. fig. 1.

Galerites patella, Lamarck? Syst. Animaux, tom. iii. p. 23. no. 14.

Clypeus patella, Agassiz, Echin. Foss. vol. i. p. 36. t. 5. fig. 4-6;

Agassiz and Desor, Cat. raisonné des Echinides, A. S. N. tom. vii. p. 156.

Nucleolites patella, Defrance, Dict. Sc. Nat. tom. xxxv. p. 213; Des-

moulins, Tabl. Synopt. no. 3. p. 354.

Echinoclypeus patella, De Blainville, Zoophytologie, p. 189.

Test orbicular, dorsal surface convex, depressed, sides sloping; vertex nearly central; ambulacral aræ broadly lanceolate, apices closely approximated; apical disc excentral, behind the vertex, and inclined posteriorly; anal valley narrowly conical, shallow, with inclining sides extending from the apex to the border; posterior lobes small; base concave and undulated; mouth excentral and pentagonal, margin with five lobes.

Height 1 inch and $\frac{6}{10}$ ths, antero-posterior diameter 4 inches and $\frac{5}{10}$ ths, transverse diameter 4 inches and $\frac{4}{10}$ ths.

Description.—This large buckler-shaped Urchin has been long known to paleontologists from the abundance and fine preservation in which its test is found in the lower and middle division

of the *Oolites*. It exhibits many changes of form in the different strata, attaining however its greatest development in the upper beds of the Inferior Oolite, from whence the specimen now before me was obtained. The ambulacra are broadly lanceolate, the single area and the anterior pair are about the same length and width, and the posterior pair are shorter and wider on the dorsal surface, and longer than the others on the base. The pores are placed widely apart, as much as $\frac{2}{10}$ ths of an inch at the widest space; they are united by transverse sulci formed by the sutures of the small plates of the ambulacral area; the poriferous avenues are more depressed, and exhibit the lines of union more distinctly than the plates occupying the interporous space, which are upon a level with the interambulacral plates, and like them are covered with tubercles; the separation of the pores and their union by transverse sutures extends to the margin of the test, at the basal angle they become approximated, and from thence to the mouth they form triple oblique pairs placed wider apart. The interambulacra are of unequal width; the anterior pair are the narrowest, the single area is the widest, and the posterior pair are of intermediate dimensions. In large specimens there is a slight depression down the centre of each area in the line of the median suture; the anal valley is narrow above and expanded below; it is of an inconsiderable depth, has an acutely conical form with inclining walls, and extends from the apical disc to the border. The anal opening is situated about the middle of the valley, the area is slightly produced and deflected, and an inconsiderable concavity is formed in its centre corresponding to the boundary of the valley. The test is thick, and its surface is profusely covered with small tubercles, so arranged that they form oblique lines; the tubercles are surrounded by circular depressions, and the intertubercular surface is occupied by microscopic granules. The vertex is nearly central, inclining in general to the posterior border, behind which the apical disc is placed, formed of two pairs of perforated ovarian plates, and a single imperforate plate which extends into the anal valley, the centre of the disc being occupied by the spongy madreporiform body; the ocular plates are small, and have the eye-holes near their margins.

The base is flat, inclining to concave; the mouth-opening is excentral and pentagonal, being situated nearer the anterior than the posterior border, and having its margin surrounded by five prominent lobes; the ambulacra form straight narrow valleys, and the interambulacra are slightly convex, which occasions gentle undulations on the basal surface, as in other *Nucleolites*; the tubercles are a little larger on the base than on the dorsal surface.

Affinities and differences.—This large species resembles *N. Agassizii* in size and outline, but is clearly distinguished from it by the flatness of the dorsal surface, the length and narrowness of the anal valley, and the absence of the undepressed portion of test which is so conspicuous in *N. Agassizii*. It resembles *N. Solodurinus* in the form and length of the anal valley, but differs from it in having an orbicular circumference, and in the absence of the produced, deflected, and truncated posterior border so characteristic of that species; from *N. Hugii* it is distinguished by the extension of the anal valley from the disc to the border, and the inconsiderable deflection of the single interambulacral area. After a careful examination of an extensive suite of specimens from the Inferior Oolite and Great Oolite, we have come to the conclusion that *C. patella*, Ag., and *C. excentricus*, M'Coy, are not distinct species, but merely varieties of *N. sinuatus*; as we have before us a series exhibiting the forms which M. Agassiz and Prof. M'Coy have considered as specifically distinct, with the intermediate forms through which they blend into the true typical *N. sinuatus*. Without several individuals from different localities, it is at all times hazardous to attempt to establish a new species of Urchin on form alone, as the same species often changes its form in different beds and even in the same bed in different localities; these modifications of form constitute at most varieties, which depended upon some temporary change of the conditions in which they lived, without in any way affecting the distinctive structural character of the species.

Locality and stratigraphical range.—*N. sinuatus* has a wide vertical range, being found very abundantly, and of its largest size, in the upper beds of the Inferior Oolite of Gloucestershire, in the Great Oolite of Minchinhampton, and Kiddington (Oxon), and the Cornbrash and Coralline Oolite of Wilts; in Yorkshire it is found in beds of the same ages. According to Agassiz and Desor the foreign distribution of this species is, "Inferior Oolite, Boulogne-sur-mer; Chayul (Ardennes); Montanville, Flincy (Meuse); Metz, Noviant, Besançon, Porrentruy, Salins (Jura); environs de Bâle."

History.—This species, as the synonyms prove, has been long known to naturalists; it is so abundant in some localities in Gloucestershire, that the farmers believe this Urchin grows in the soil, from the numbers that are successively turned up by the plough every year.

Nucleolites Agassizii, Wright, n. sp. Pl. VII. fig. 3 a-c.

Test conoidal, with a nearly circular margin; ambulacral areas depressed, concave and petaloid, anterior pair much inclined;

apices remote ; pores widely apart ; interambulacral areas nearly of the same width ; vertex central ; apical disc excentric, and inclined backwards ; anal opening of an oblong form, situated in a shallow valley in the middle of the single interambulacrum ; between the upper anal border and the disc there is a considerable undepressed portion of the test ; base flat and very slightly undulated ; mouth nearly central, pentagonal, and surrounded by five prominent lobes ; the tubercles on the dorsal surface are quite microscopic, those on the base are a little larger and more distinct.

Height 2 inches and $\frac{2}{3}$ ths, antero-posterior diameter 4 inches and $\frac{2}{3}$ ths, transverse diameter 4 inches.

Description.—This noble Urchin preserves the conoidal elevation of its dorsal surface in all the individuals we have examined. The circumference is nearly orbicular, the antero-posterior being somewhat greater than the transverse diameter ; the dorsal surface of the test is uneven in consequence of the ambulacra forming concave depressions, which have a petaloidal form, and are of a nearly uniform width ; the single area and the inferior pair are the longest, the latter are much inclined, and the posterior pair are slightly flexuous ; the central space between the pores is narrow, and lies lower than the general surface of the interambulacra. The pores are situated at a considerable distance apart on the dorsal surface and become approximated at the basal angle, where they fall into close-set pairs, from thence to the mouth they are arranged in triple oblique rows ; the pores are extremely small and indistinct on the basal surface. The interambulacral areas are very uniform in width and convexity on the dorsal surface, the anterior pair are the longest, and the single area has a remarkable form arising from the shallowness of its anal valley, and the superficial position of the anal opening which forms an oblong depression in the middle of the area ; between the upper border of the opening and the disc there is a smooth, slightly depressed portion of the test to the extent of an inch, which is the rudiment of the furrow so much developed in some *Nucleolites*, and which forms one of the most important diagnostic characters of our species ; from the lower border of the opening the test is depressed, the limits of the depression being bounded by two elevations ; the basal angle of this area is very slightly produced and deflected, the posterior lobes are entirely obsolete. The vertex is central, and at a short distance behind it the apical disc is situated, which is considerably inclined towards the posterior border, and formed of an anterior and a posterior pair of perforated ovarian plates, and a single imperforate plate with a large central portion, having a spongy madreporiform body attached to its surface, and

which occupies the centre of the disc; the five ocular plates are small, and so firmly soldered to the ovarials that the line of the sutures is entirely effaced. The base is flat and slightly undulated, the interambulacral segments being moderately convex and separated from each other by the straight, narrow ambulacral valleys. The mouth is nearly central, of a pentagonal form, and surrounded by five prominent lobes formed of the terminal folds of the interambulacra; the tubercles on the dorsal surface are very small and numerous, so that without the aid of a lens the test appears smooth; on the basal surface they are larger, but are still comparatively small for so large an Urchin.

Affinities and differences.—*N. Agassizii* resembles *N. sinuatus* in size, but is readily distinguished from that common species by the following diagnostic characters. In *N. Agassizii* the dorsal surface is conoidal, the ambulacra are concave and depressed, the anal opening is oblong and nearly superficial; there is a considerable extent of the test very slightly depressed between the upper border of the opening and the disc, whilst in *N. sinuatus* the anal valley extends from the disc to the border. The tubercles are much smaller, and the dorsal surface is almost smooth. The apical disc is large, superficial, and excentric.

Locality and stratigraphical range.—This Urchin was collected from the sands of the Inferior Oolite in the neighbourhood of Bridport. It occurs likewise near Ilminster in beds of the same age. I know of no specimens in Gloucestershire. I dedicate this species to Professor Agassiz, whose numerous monographs on the Echinoderms, living and fossil, have so materially contributed to advance our knowledge of this class.

Nucleolites emarginatus, Forbes.

SYN. *Echinites subulatus*, Young and Bird, Geol. Surv. York. Coast, p. 214. pl. 6. fig. 11.

Clypeus emarginatus, Phillips, Geol. of Yorksh. p. 127. pl. 3. fig. 18.

Nucleolites emarginatus, Forbes, Mem. of the Geol. Surv. Decade 1. description of pl. 9.

“Test orbicular, sides declining, dorsal surface subdepressed; vertex and apical disc nearly central; ambulacra broadly lanceolate, with their apices approximated; anal valley very short, far removed from the vertex, obtuse and marginal; posterior lobes obsolete.”—*Forbes*.

Antero-posterior and transverse diameters about 4 inches.

We could not succeed in obtaining a specimen of this *Nucleolite*; it is said to be rare. Mr. Young observes, “that the dorsal surface has the same elegant markings as No. 5 (*Pygurus pentagonalis*), but the petals are rather oval shaped than lanceolate, from which peculiarity we name it *Echinites subulatus*.”

The middle part of each petal forms a slight ridge ; on the contrary, the five corresponding marks on the base meeting in the mouth are depressed. The base is concave. The mouth is situated immediately under the vertex. The vent is in a short groove, on the edge, but more towards the upper surface, as in some of the *Spatangus* family."

Affinities and differences.—The marginal position of the anal valley forms a sufficient diagnosis between *N. emarginatus* and its congeners, but the want of a specimen prevents us making a comparison between it and them ; the petaloidal ambulacra and position of the anus bring this Urchin into near affinity with the genus *Pygurus*.

Locality and stratigraphical range.—It is found in the Coraline Oolite of Malton and Scarborough, and is said to be rare.

History.—This Urchin has been figured by Messrs. Young and Bird and by Mr. Phillips, but described by neither. Prof. Forbes has drawn up a good diagnosis of the species, but a detailed description is now a desideratum.

In the 'Catalogue raisonné des Echinides' of Agassiz and Desor there is a species entered under the name of *Clypeus rimosus*, described as "Espèce plate, discoïde, à ambulacres costales," and stated to be from the Oolitic strata of Gloucestershire, and in the collection of M. Deluc ; we know of no such species from the Oolites of this county, and suspect that it may probably be one of the many varieties which *N. sinuatus* presents in our different beds. There is a small *Nucleolite* in the British Museum from the Great Oolite of Harleston, apparently distinct and allied to *N. clunicularis* ; in the same collection there is another small species from the Inferior Oolite of Stroud which is probably new*.

In Prof. M'Coy's paper "On some new Mesozoic Radiata †," there are two species described under the names of *N. planulatus* and *N. æqualis*, neither of which we know ; the former is said to resemble *N. planatus* of Roemer, and the latter *N. latifrons* (*latiporus* ?), Agassiz, which is only an orbicular variety of *N. clunicularis* from the Cornbrash.

A careful comparison of these forms, with other typical species and the varieties thereof, is very desirable, as the creation of new species from transitory forms retards rather than advances palæontology.

Genus PYGURUS, Agassiz.

Test discoid or ovoid, more or less elevated ; anterior border flattened, posterior border rostrated ; ambulacra having elegant petaloid forms ; poriferous zones very large in the centre, much contracted at the vertex and towards the border ; apical disc small,

* Prof. Forbes, Mem. Geol. Surv. Decade 1. pl. 9.

† Annals of Nat. Hist. vol. ii. Second Series, p. 416.

subcentral, and formed of four perforated and a single imperforated ovarian plate, with a small madreporiform body occupying the centre of the disc, and five ocular plates the angles between the ovarials at the circumference thereof. Interambulacra wide, the single area produced and deflected; anal opening round or longitudinally oval, situated in the infra-marginal border of the rostrated process. Ventral surface concave or subconcave; mouth subcentral and pentagonal, surrounded by five prominent lobes and a rosette of well-developed pores on the ambulacra near the opening. Tubercles close-set and microscopic. Most of the species are Oolitic, a few are found in the Neocomian strata, but all are extinct.

Pygurus Blumenbachii, Agassiz. Pl. VIII. fig. 2 a-c.

SYN. *Clypeaster Blumenbachii*, Koch and Dunker, Norddeutschen Oolithgebild. pl. 4. fig. 1. p. 37.

Pygurus Blumenbachii, Agassiz and Desor, Cat. raisonné, A. N. S. tom. viii. p. 162.

Test thin, nearly orbicular, with a sinuous margin; dorsal surface elevated anteriorly, gradually declining posteriorly, border sinuous, with the centre produced and deflected; base concave, much undulated; mouth-opening excentric, subpentagonal, with a five-lobed margin; anal opening submarginal, round or nearly ovate.

Height 1 inch and $\frac{1}{10}$ th, antero-posterior diameter 2 inches, transverse diameter at the widest part 2 inches and $\frac{1}{10}$ th.

Description.—This Urchin has a very remarkable form; the anterior border is slightly excavated in the centre, with two convex lobes on each side thereof. The lateral parts of the test are convex, and the posterior borders form two sinuous lines having the centre of the single interambulacrum produced posteriorly into a beak-shaped, slightly deflected process. The ambulacra have an elegant petaloid form with approximated apices; the poriferous avenues are marked by well-developed transverse sulci. The ambulacral aræ, which are wide above, rapidly converge towards the lower third; the pores here approximate and pass from thence in close-set pairs to the border of the test. Along the base the pairs are placed wide apart, but again become more closely approximated as they approach the mouth.

The interambulacra are unequal; the anterior pair are convex and prominent; they rise nearly perpendicular, forming an angle of 80° , and near the vertex curve backwards; the posterior pair and the single area slope at an angle of 35° . The dorsal surface thus acquires the anterior elevation which gives so remarkable a character to this species, and connects it with *P.*

Montmollini from the Neocomian stage. The single interambulacrum is remarkable from having a central elevation on its dorsal surface, two sinuous excavations commencing from the posterior pair of ambulacra, and a central produced and deflected portion. The vertex is excentral, in which the small apical disc is situated, formed of four perforated ovarian plates and a single imperforate plate, with the spongy madreporiform body occupying the centre and five ocular plates the apices of the ambulacra. The base is concave and much undulated, the ambulacra forming straight valleys from the border to the mouth, and the interambulacra convex eminences between them. Near the mouth their terminal portions form five very tumid lobes around the margin of that opening. The mouth is subpentagonal and placed diametrically opposite to the apical disc; it is consequently excentral and nearer the anterior border. The anal opening is not shown in our specimen; according to Koch and Dunker, it is somewhat ovate inclining to round, and is situated in the basal portion of the produced and deflected single area.

Affinities and differences.—This singular Urchin, in its elevated anterior dorsal surface, very much resembles *P. Montmollini*, Ag., from the Neocomian stage of Switzerland, and *P. trilobus* from the Craie chloritée of Maers; from the former it is distinguished by the more angular outline of the posterior border, from the latter it differs in having the central lobe less produced. The form, in fact, is intermediate between them.

Locality and stratigraphical range.—The specimen before me, I was assured, was collected from the ferruginous beds of the Inferior Oolite near Yeovil, and the lithological character of the matrix supports the statement. It has been found by the officers of the Geological Survey in the Coral Rag of Abbotsbury, Dorsetshire, a fine specimen of which is in the Mus. of Pract. Geol. Its foreign distribution is the Coral Rag de Jonnerre (Yonne) and of Waltersberg (Hanover).

History.—First figured and described by Koch and Dunker in their monograph on the 'Norddeutschen Oolithgebilde,' afterwards identified by Prof. Forbes in the collection made by the Geological Survey in Dorsetshire, and now described as a British Urchin for the first time.

Pygurus pentagonalis, Wright. Pl. VIII. fig. 8 a-e.

SYN. *Echinanthites orbicularis*, Young and Bird, Geol. York. Coast, pl. 6. fig. 5.

Clypeaster pentagonalis, Phillips, Geol. of Yorksh. tab. 4. fig. 24.

Test with an ovoidal or subpentagonal circumference, much depressed on the dorsal surface; vertex nearly central, in which the apical disc is situated; ambulacral areas petaloid, broad,

convex, and nearly equal; apices closely approximated; interambulacral areas of unequal width, base much undulated; mouth nearly excentral; anal opening oval, inframarginal, and situated in a deep depression with inclining walls.

Height 1 inch and $\frac{2}{10}$ ths, antero-posterior diameter 3 inches and $\frac{5}{10}$ ths, transverse diameter 3 inches and $\frac{1}{10}$ th.

Description.—This Urchin was first noticed by Mr. Young in the Coralline Oolites of Yorkshire. It has an ovoidal or subpentagonal form and is much depressed, the vertex is nearly central, and from the circumference of the small disc the broad petaloid ambulacra diverge. The anterior single ambulacrum is the narrowest, the posterior pair the widest, and the anterior pair of intermediate width, but the difference between the five ambulacra is very trifling; they have all a petaloid form and their apices are blunt and much approximated.

The space between the internal rows of pores is proportionally broad, and the pores are distant and connected by distinct sulci; about the inferior third of the ambulacra the pores approximate, from whence they pass in close-set pairs to the border of the test. The leaf-like form, therefore, which the ambulacra present is in a great measure owing to the disposition of the pores and their proximity or remoteness at different parts of their course. The interambulacra are of unequal width; the anterior pair are the narrowest, and the posterior pair and single area are alike in width; they are uniformly convex above. The single area is produced and deflected, and in this region the anus is situated; the apical disc, which occupies the centre of the vertex, is very small, depressed, and composed of four small perforated ovarian plates, and a single imperforate plate with a small central spongy body as in *Nucleolites*. The base is flat, somewhat concave, and much undulated in consequence of the ambulacra forming straight valleys and the interambulacra intermediate convexities. The anterior border is truncated, and as the left interambulacrum is not so much developed as the right, there is a slight inequality of the anterior border, which may however be only an abnormal variety; the anus occupies the extreme portion of the single interambulacrum, it is of an oval form, the long diameter corresponding to the antero-posterior diameter of the test, and is situated in a deep depression with highly inclined sides. The mouth is slightly excentral, but is partly concealed by the matrix.

Affinities and differences.—This species so very much resembles *Pygurus (Clypeaster) Hausmanni* of Koch and Dunker, that we have been almost disposed to consider the latter as a gigantic example of this species. The dorsal surface of *C. Hausmanni* is flatter and more convex, the poriferous sulci are shorter, and the

anus forms a blunter oval. A comparison of these specimens is therefore very desirable, as size alone *cateris paribus* does not constitute a specific character.

I have before me a large *Pygurus* from the Coralline Oolite of Malton, Yorkshire, belonging to the collection of the Bristol Institution, and kindly lent me for comparison by Mr. Etheridge the curator.

It so much resembles the *Clypeaster Hausmanni*, Dunk., in proportional measurements, whilst it exceeds that Urchin in size, that we think it identical with the German species: this *Pygurus* measures in height 1 inch and $\frac{2}{10}$ ths; antero-posterior diameter 5 inches and $\frac{6}{10}$ ths; transverse diameter 5 inches and $\frac{8}{10}$ ths. The test is thin, the tubercles are small and numerous; the ambulacra are prominent, projecting above the level of the interambulacra, and describing similar petaloidal figures to those in *P. pentagonalis*; the ventral surface is inseparably united to the rock, and a portion of the single interambulacrum is fractured. Notwithstanding these defects, the likeness to *C. Hausmanni* is so great, and the structural affinities so numerous, that we think we are justified in our conclusion as to their identity: according to Koch and Dunker the dimensions of *Clypeaster Hausmanni* are—"Height 11 lines; antero-posterior diameter 4 inches and 7 lines; transverse diameter 4 inches and 2 lines. L : B : H = 100 : 90 : 20." The *Pygurus* before us exceeds therefore by one-fifth in size this gigantic German Urchin.

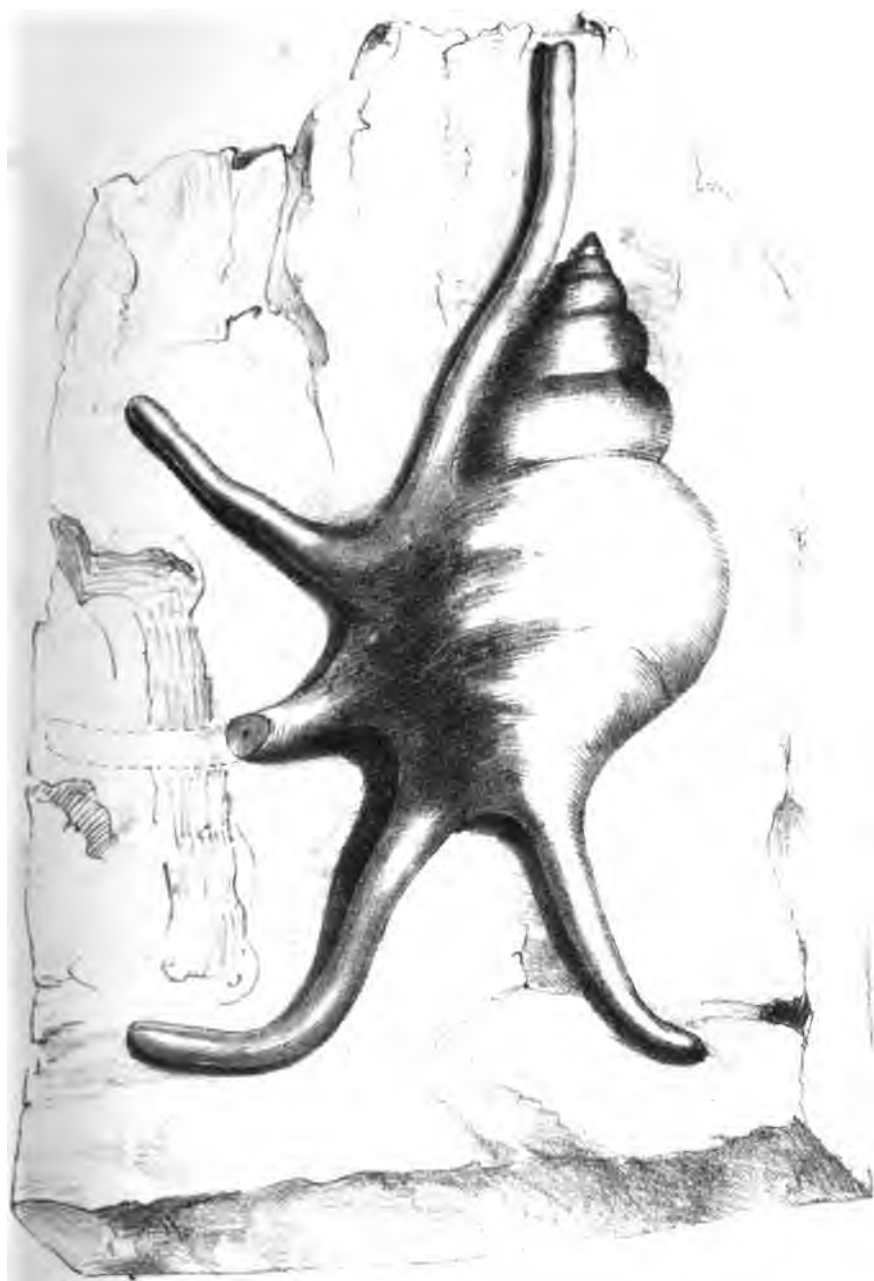
Locality and stratigraphical range.—*Pygurus pentagonalis* has been collected from the upper rags of the Inferior Oolite at Shurdington Hill: it is a rare Urchin in these beds, as I only know of two individuals having been obtained therefrom; it has been found in the Inferior Oolite of the district round Bath, and was collected by Mr. Young and Mr. Phillips from the calcareous grit of Yorkshire. *P. Hausmanni*, which in some respects resembles our *P. pentagonalis*, was found in the Upper Coralline Limestone of Kleinenbremen near Bückeburg.

History.—I have not been able to compare our specimens with those from the Coralline Oolite of Yorkshire, but have every reason for believing that they are identical, although the figure in Mr. Phillips's work is certainly more pentagonal than ours.

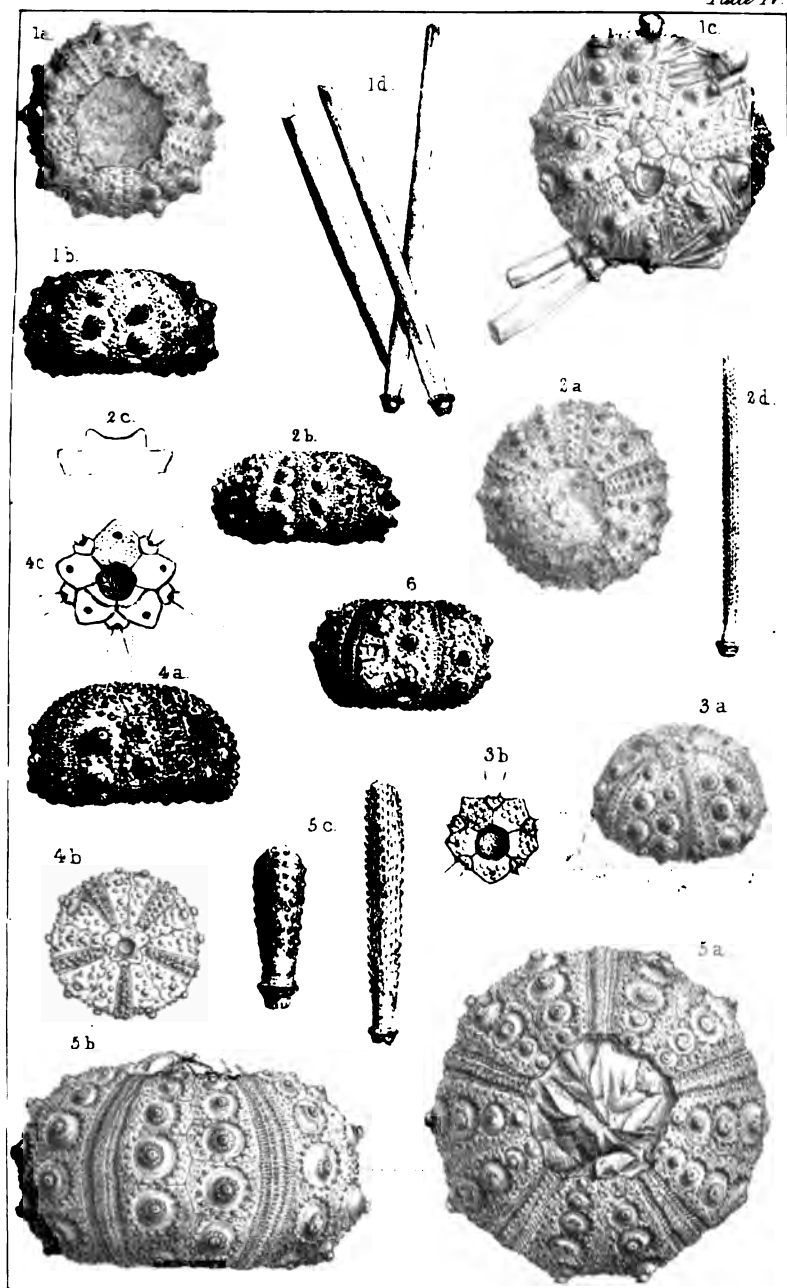
In conclusion I take this opportunity of thanking Messrs. Brodie, Etheridge, Forbes, Fowler, Gavey, Jones, Lycett, Morris, Strickland, Walton, Wayte, Waterhouse, and Woodward for the loan of and permission to compare specimens, and Mr. W. H. Baily for the care he has taken to make out the details of our new species. I have subjoined a table which exhibits at one view the range and stratigraphical distribution of the Urchins described in the preceding papers.

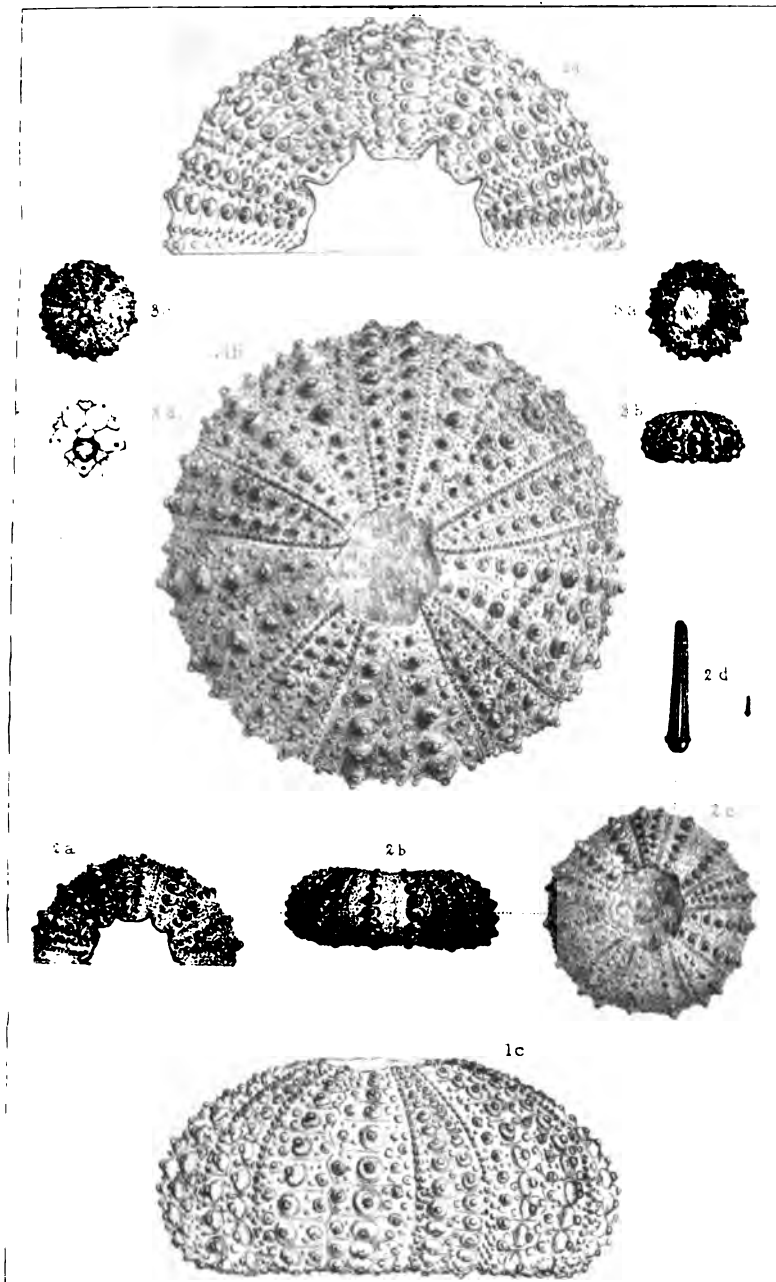
A Tabular View of the Stratigraphical Distribution of the Jurassic Cidaridæ and Cassidulidæ described in the preceding Papers.

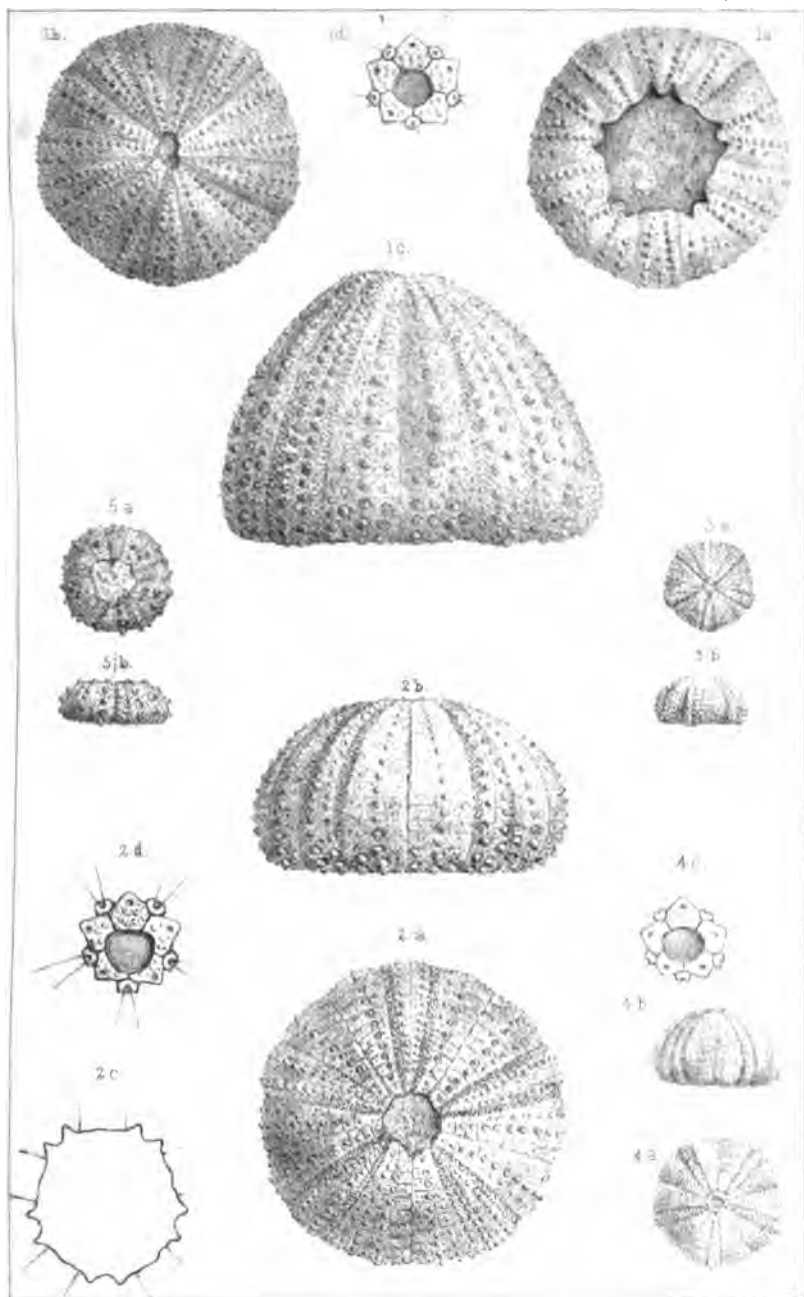
Genera and Species.	Authority.	Inferior Oolite.	Great Oolite.	Bradford Clay, Corbrash, and Forest Marble.	Oxford Clay.	Calcareous grit and Coralline Oolite.
CIDARIDÆ.						
<i>Cidaris Fowleri</i>	Wright ...	*	...	...	...	...
<i>Blumenbachii</i>	Münster...	...	...	...	...	*
<i>propinqua</i>	Münster...	*	...	...	...	...
<i>Hemicidaris intermedia</i>	Fleming ...	...	*	*	...	*
<i>icaunensis</i>	Cotteau ...	...	*	...	...	...
<i>alpina</i>	Agassiz ...	...	...	*	...	...
<i>granulosa</i>	Wright ...	*	...	...	...	...
<i>confluens</i>	M'Coy ...	...	...	*	...	...
<i>pustulosa</i>	Forbes ...	...	*	...	...	...
<i>Acrosalenia hemicidaroides</i> ..	Wright ...	*	*	*	...	...
<i>Lycetti</i>	Wright ...	*	...	...	...	...
<i>spinosa</i>	Agassiz ...	...	*	*	...	...
<i>decorata</i>	Haime ...	...	...	...	...	*
<i>Wiltonii</i>	Wright ...	...	...	*	...	...
<i>Diadema depressum</i>	Agassiz ...	*	*	*	...	*
<i>subangulare</i>	Goldfuss ...	...	...	...	...	*
<i>pseudo-diadema</i>	Lamarck...	...	...	...	...	*
<i>Pedina rotata</i>	Agassiz ...	*	...	...	...	...
<i>Echinus perlatus</i>	Desmarest	*	*	...	...	*
<i>serialis</i>	Agassiz ...	*	*	...	...	...
<i>granularis</i>	Wright ...	*	...	...	...	...
<i>gyratus</i>	Agassiz ...	...	...	...	...	*
<i>Arbacia Forbesii</i>	Wright ...	*	...	...	...	...
<i>nodulosa</i>	Wright ...	...	*	...	...	...
CASSIDULIDÆ.						
<i>Pygaster semisulcatus</i> ?	Phillips ...	*	*	...	...	*?
<i>conoideus</i>	Wright ...	*	...	...	...	...
<i>Morrisii</i>	Wright ...	...	*	*	...	...
<i>Holactypus depressus</i>	Lamarck...	*	*	*	...	*
<i>hemisphaericus</i>	Desor ...	*	...	...	...	...
<i>Hyboclypus agariciformis</i> ...	Forbes ...	*	...	...	...	...
<i>caudatus</i>	Wright ...	*	*	...	...	...
<i>gibberulus</i>	Agassiz ...	*	...	...	...	...
<i>Dysaster ringens</i>	Agassiz ...	*	...	*?	...	...
<i>bicordatus</i>	Desor ...	*	...	...	...	...
<i>ovalis</i>	Parkinson	...	...	...	*	*
<i>analis</i>	Agassiz ...	*	...	...	...	...
<i>Nucleolites clunicularis</i>	Lilhywd ...	*	*	*	...	...
<i>dimidiatus</i>	Phillips ...	...	...	...	...	*
<i>Hugii</i>	Agassiz ...	*	...	...	...	...
<i>orbicularis</i>	Phillips ...	*	*	*	...	...
<i>Solodurinus</i>	Agassiz ...	*	...	...	...	...
<i>sinuatus</i>	Leske ...	*	*	*	...	*
<i>Agassizii</i>	Wright ...	*	...	...	...	...
<i>emarginatus</i>	Phillips ...	...	...	...	...	*
<i>Pygurus pentagonalis</i>	Wright ...	*	...	...	...	*
<i>Blumenbachii</i>	Koch and Dunker	*?	...	...	...	*

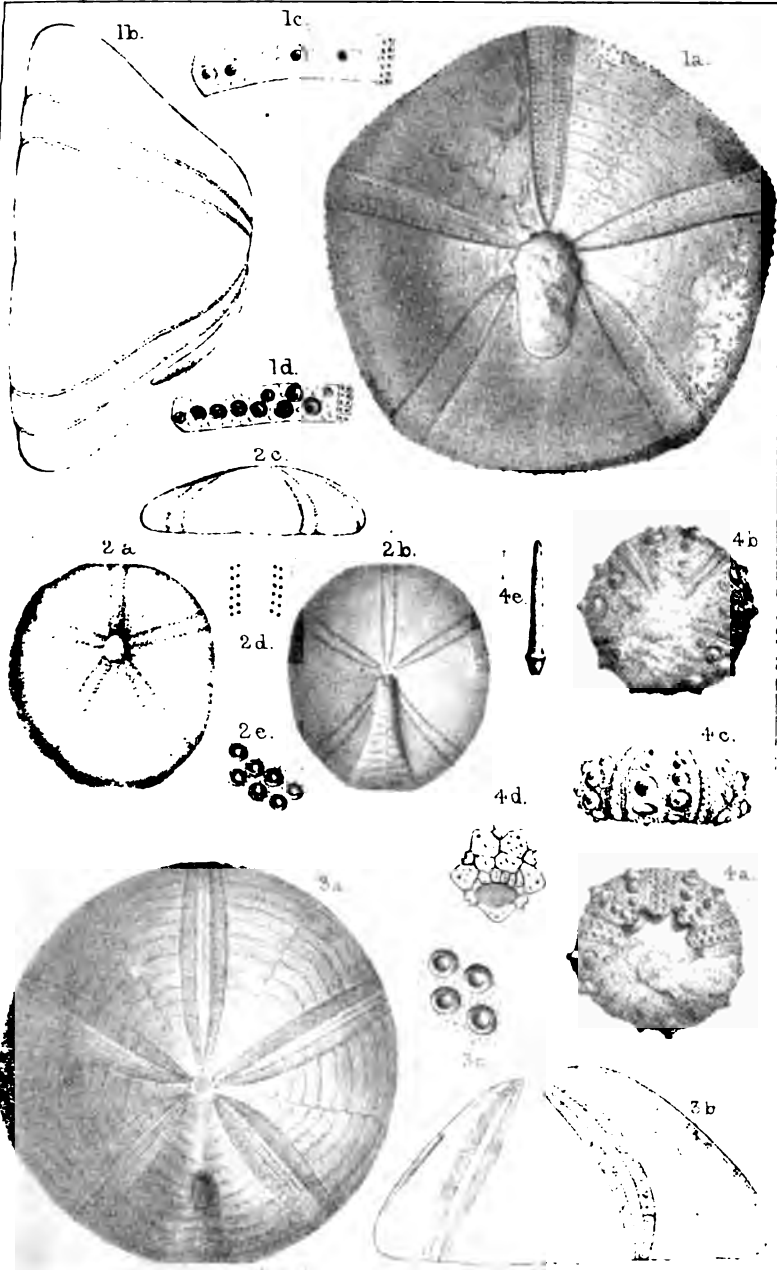


Pteroceras Wrighti (Lyell)
Great Oolite of Minchinhampton







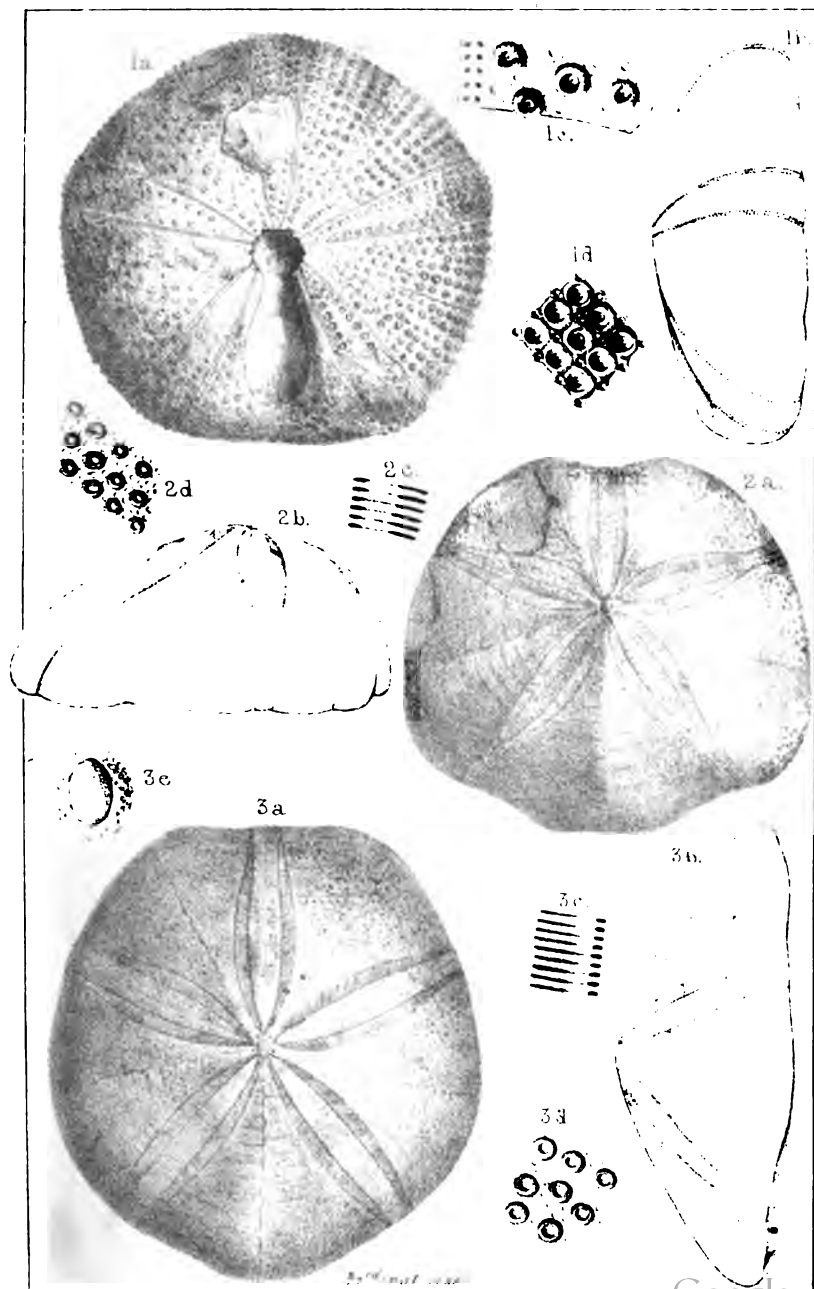


W. H. R. G.

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1 a. d. *Pygaster conoides*, Wright
 2 a. a. *Hybolytus caudatus*, "
 3 a. c. *Nucleolites Agassizii*, "
 4 a. e. *Aerosalenia Wiltoni*, "

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W. H. Bailey

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Printed by J. H. Johnson & Co., Wash. D. C.

1a-d Pygaster Morrisii, Wright
2a-d Pygurus Blumenbachii, Koch & Junker
3a-d Pygurus Blumenbachii, Wright

Contributions to the Palæontology of the Isle of Wight.

By THOMAS WRIGHT, M.D. &c.

READ 4TH MAY 1852.

IT has been supposed that the tertiary beds of England, when compared with those of the continent of Europe, are deficient in mammalian remains; this opinion, like many other hasty generalizations, if it be not entirely fallacious, requires modification. The valuable series of mammalian remains obtained from time to time from the lacustrine strata of Kyson, Hordwell, and the Isle of Wight, lead us to believe that if similar facilities existed in these localities for working the beds from whence mammalian bones and teeth are obtained, as is the case in the neighbourhood of Paris, the richness of the English tertiaries in these remains would no longer be a doubtful question. We have been led to this conclusion from facts which have come under our observation during the two consecutive summers we were engaged in drawing up a description of the coast sections of Hampshire and the Isle of Wight, and which have already appeared in the pages of our Proceedings. Until last summer no remains of the new genus *Dichodon* had been found, except in one spot in the Hordwell section, when I had the good fortune to discover, near Alum Point, Isle of Wight, a portion of the lower jaw of this singular genus with the true molars "*in situ*" in beautiful preservation. This jaw fortunately supplies some points in the anatomy of this rare mammal, which were absent in the only specimen hitherto found, and which it is the object of this note to furnish.

Dichodon cuspidatus, Owen.

The dental formula of the lower jaw of *Dichodon cuspidatus*, according to Professor Owen, consists of three incisors, one canine, four premolars, and three true molars, arranged in a continuous series in each ramus, and it is inferred that these were opposed by the same number of teeth in the upper jaw. "There are wanting therefore to establish *ex visu* the entire dental series, only the first and second premolars of the upper jaw and the last true molar of the lower jaw, the germ of which had not been sufficiently calcified at the time of the animal's death to yield satisfactory evidence of its true form*." Having recently dis-

* Quart. Journ. Geol. Soc. vol. iv. p. 42.

covered a portion of the left ramus of the lower jaw of this rare mammal in the lower freshwater formation of the Isle of Wight, containing the three true molars in an admirable state of preservation, I am enabled to supply a description thereof.

The crowns of all the true molars exhibit a double series of sharp conical lobes; the teeth are fixed obliquely in the jaw, their crowns having a direction forwards, inwards and upwards, the obliquity of the inclination increasing from before backwards; the first and second molars are nearly alike in size, form and structure; the first, however, is somewhat smaller than the second; the crown of each tooth rises high above the ramus of the jaw; it consists of four semiconical-shaped lobes, two external and two internal, separated from each other by a deep transverse and a shallow longitudinal valley; the two external lobes are sharply lanceolate; each has a median ridge of enamel and two sharp supernumerary processes or cusps, situated at the external sides of the base of each lobe; the inner surface is convex and smooth, and as the apices of the lobes are not worn, the double fold of enamel, with its intermediate dentine, is beautifully shown in our specimen.

The internal lobes are larger and more fully developed than the external pair, but their apices do not attain the same height as those of the external lobes; their internal surface is smooth and convex, their external surface is moderately concave, and inclined to a high angle; at the base of the external surface of each of the internal lobes there are two small tubercles or rudimentary cusps: the posterior marginal surface of all the lobes is slightly polished by dentition, whilst their sharp lanceolate points are not worn, from which circumstance it may be logically inferred, that the lobes of the teeth of the lower jaw locked into corresponding spaces in those of the upper jaw, as in the hedgehog (*Erinaceus europæus*), the mole (*Talpa vulgaris*), and other Insectivora.

The third true molar differs from the first and second in possessing six instead of four lobes; the four anterior lobes are of the same form and structure as those of the second molar, only they are somewhat larger; the third or posterior pair are smaller than either of the others, and they have a more rudimentary form; the anterior cusp is absent at the base of the external lobe, and the posterior cusp is a small process which rises between the external and internal lobes.

Locality.—I found this rare fossil in a bed of greenish tough tenacious clay, being No. 35 of my section*, and which stratum I have shown to be the equivalent of No. 14 of my section of

* See p. 98 of these Proceedings.

Hordwell, Beacon, and Barton Cliffs*, from whence Mr. Falconer obtained the specimen which formed the subject of Professor Owen's paper. It is important, therefore, to note that these mammalian remains have been found in precisely the same geological horizon on both shores of the Solent sea; thus affording another link in the chain of evidence which proves the former union of these tertiary beds. I have promised the loan of this specimen to Professor Owen, who will figure it in the forthcoming new edition of his 'British Fossil Mammalia;' for this reason I have not figured it here.

Tooth of an unknown Saurian.

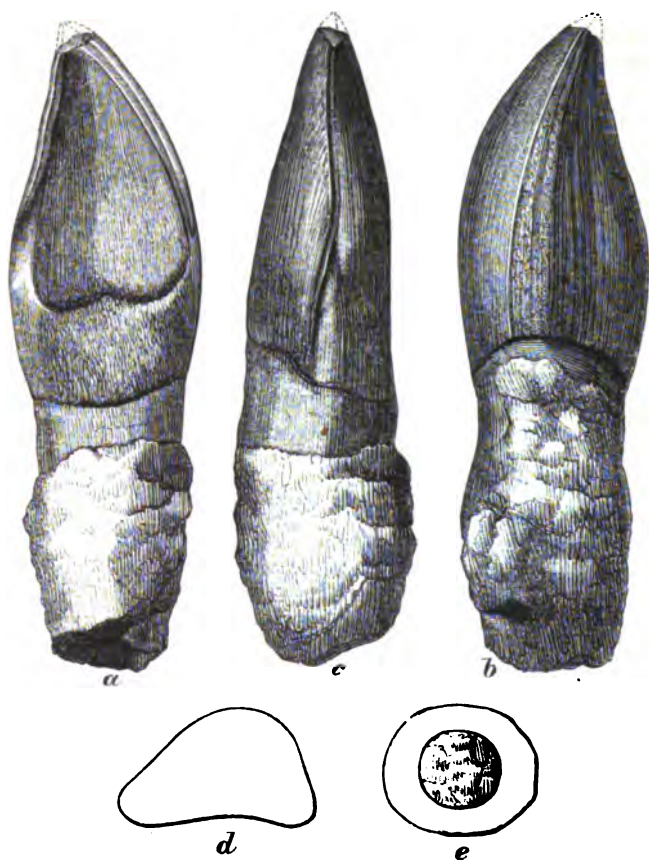
I had the good fortune to meet with a very perfect reptilian tooth in the Wealden clay of Brixton Bay; the accompanying figure, of the natural size, was drawn on wood by Mr. W. H. Baily, as it is important that palæontologists should possess a faithful drawing of its singular form, to enable them to compare future discoveries with the subject of this note, and eventually to determine the genus of Saurians to which it belonged. I had the pleasure of showing this tooth to Professors Forbes, Gervais and Owen, Dr. Mantell, and Messrs. Waterhouse and Woodward, who were all unacquainted with the form. Dr. Mantell thought it had some resemblance to a tooth found in the Wealden of Tilgate Forest, and which he imagined belonged to the *Hylosaurus*. "These teeth," he observes, "are about $1\frac{1}{4}$ inch in height, and commence at the base with a cylindrical shank, which gradually enlarges into a crown of an obtusely lanceolate form, convex in front, slightly depressed, and terminating in an angular rounded apex, the margins of which are generally more or less worn, as if from dentrition. The crown is solid, but the fang encloses a small pulp-cavity; the surface is enamelled, and covered with very fine longitudinal striæ; the base in every specimen appears broken transversely, and has not a smooth surface, as if it had been loosened by absorption and shed naturally†." The Doctor has given a figure of this tooth which differs so much from our specimen, that we cannot suppose it belonged to a reptile of the same genus.

Description.—Our new tooth is divisible into the crown and the root: the line of demarcation between these parts is clearly defined by the terminal undulation of the enamel. The crown is somewhat of a bayonet-shape; from the frontier line of the enamel to the apex, it measures in front 1 inch and $\frac{1}{8}$ ths; behind 2 inches and $\frac{1}{8}$ th; the antero-posterior diameter at its

* See p. 120 of these Proceedings.

† Hand-Book of the Fossils of the British Museum, p. 326.

widest part exceeds 1 inch, and its transverse diameter is $\frac{6}{10}$ ths of an inch (*d*).



The crown (*d, b, c*) is unequally convex in front and concave (*a*) behind. The general form of the crown is shown in *a, b, c*; the anterior side thereof (*a, b*) is convex and sabre-shaped, and the posterior border (*a, b*) is slightly concave; the external convex surface (*b*) is covered with smooth enamel, which forms four blunt ridges on its most prominent part, and terminates inferiorly in a delicate rugous structure, forming a well-defined arch (*b*), the convexity of which is directed towards the apex; the posterior surface of the crown (*a*) is flat below and concave above; the enamel is smooth above and rugous below, as on the anterior surface, but it extends much farther down the crown (nearly half an inch) and forms an arch, the convexity of

which is directed towards the root; the internal surfaces of the anterior and posterior borders (*a*) are abruptly truncated, apparently by dentition, and near the base of the posterior border there is an oblique fold or depression, close to which are marks of abrasion by dentition: the unequal extent of the enamel on the external and internal surfaces of the crown proves that the external plate of the ramus of the jaw was deeper on the external than on the internal side.

The root (*a, b, c, e*) is nearly cylindrical; from the external terminal fold of enamel to its fractured part, it measures 1 inch and $\frac{8}{10}$ ths; its surface is much concealed by the matrix, and has masses of pyrites adhering thereto; it forms a hollow cylinder (*e*) which inclosed a pulp-cavity; the structure and form of the root is that of a tooth which was implanted in a distinct alveolus of a large and powerful jaw. Part of the apex is broken off, the position of which we have indicated by dotted lines; there can be no doubt that it was sharply pointed, and that this tooth was an instrument destined to pierce the soft structures of other animals, and consequently that it belonged to an extinct genus of carnivorous reptiles.

Diadema Autissiodorensis, Cotteau.

SYN. *Diadema Autissiodorensis*, Cotteau, Cat. Méthod. des Echinides dans l'étage Néocomien, p. 5.

Test pentagonal, depressed; interambulacral tubercles a little larger than those of the ambulacral areas, more especially as they approach the ovarial disc; interambulacral areas with two rows of primary tubercles, and two incomplete series of secondary tubercles at the ambulacral sides thereof, which gradually disappear on the upper surface; ambulacral areas prominent, with two rows of primary tubercles much diminished in size at the upper surface. Pores in a double series near the ovarial disc and at the circumference of the mouth.

Height $\frac{4}{10}$ ths of an inch; transverse diameter $\frac{1}{2}$ ths of an inch.

Description.—In its general outline this beautiful Urchin resembles *D. depressum* of the Inferior Oolite, but the details of its structure are very distinct from that form. The circumference is pentagonal from the convexity of the ambulacral areas, and the base and summit are much depressed.

The interambulacral areas are one-third broader than the ambulacral; two rows of primary tubercles occupy the centre of the plates; there are about ten pairs of tubercles in each area, which are of a moderate magnitude, and gradually diminish in size from the circumference to the base and summit; the mani-

millary eminences are small, their summits are deeply crenulated, and the tubercles, of proportional size, are deeply perforated; at the circumference six rows of granules separate the tubercles from each other, but towards the upper surface the four central rows are absent, which leaves a naked space in the middle of the area; three rows of granules in like manner separate the tubercles from the poriferous valleys; at the base of the area, and extending as far as the circumference of the test, are incomplete rows of secondary tubercles; these gradually diminish in size and disappear at the upper surface, which is occupied with an unequal-sized, close-set granulation about three rows deep; the ambulacral areas are one-third narrower than the interambulacral, they are however very prominent and convex, and are occupied with two rows of primary tubercles about ten in a row; the lower six pairs of tubercles are nearly as large as the corresponding tubercles in the interambulacral areas, but the upper four pairs are much smaller, so that whilst there is a great uniformity in the size and form of the tubercles on the base and circumference of the test, there is a very marked difference between those of the ambulacra and those of the interambulacra in the vicinity of the ovarian disc; the intertubercular space is occupied by a zig-zag band of granulation, which is narrow below where the tubercles are large, but becomes broader above where they are small. The pores are arranged in double pairs near the summit and mouth, but in the other part of the avenues they are in single pairs; the apical disc is absent in our specimen, and the mouth is large and decagonal.

Affinities and differences.—This species nearly resembles *D. Bourgueti*, Ag., but differs from it in the rudimentary condition of the upper tubercles of the ambulacra, and in having the pores in double pairs above and below; the intermediate granulation is likewise less homogeneous than in *D. Bourgueti*.

Locality.—I collected this Urchin from the lower greensand at Atherfield, in No. 4 of the Cracker group of Dr. Fitton's section: it must be very rare, as none of the cabinets of Atherfield fossils hitherto examined by me contain a specimen of this *Diadema*. It has been collected by M. Cotteau from the Néocomien stage at Auxerre, where it is likewise very rare.

History.—Discovered by the author in the Isle of Wight in 1850, and by M. Cotteau in France in 1851, but first described by the latter in his 'Catalogue Méthodique des Echinides recueillis dans l'étage Néocomien,' and which brochure I received since I read this communication. As there is no figure of this Urchin extant, I intend giving one of the beautiful specimen before me, along with some other new forms of that group which I hope shortly to publish.

Note on the Gryphæa of the Bed called Gryphite Grit in the Cotteswolds. By JOHN LYCETT, Esq.

READ FEBRUARY 1853.

THE lower bed of the upper ragstones in the Cotteswold Inferior Oolite exhibits an immense profusion of a well-known Gryphæa, and this circumstance, together with the very limited stratigraphical range of the shell, combines to render it of much importance to the geologist, as it affords a certain guide to that portion of the Inferior Oolite. This Gryphæa has been universally accepted as the *G. cymbium* of Lamarck, but the position of that species upon the continent is known to be the Middle Lias, of which it is considered to be one of the characteristic forms, and a reference to the figures and descriptions of Lamarck's shell proves that it is perfectly distinct from the Cotteswold species. In the first edition of the 'Geology of Cheltenham,' by Sir R. Murchison, the Gryphæa is tabulated *G. cymbium*, and this name was copied into the second edition, in which however, fortunately, an illustration was given of it at pl. 7. fig. 3. Subsequent lists of Inferior Oolite fossils have included *Gryphæa cymbium*. It does not appear that Lamarck's species has been recognised in the lias of England; it possesses a general resemblance to *G. incurva* and *G. obliquata*, except that the larger valve has much less convexity, the beak is much less incurved, and has a small area by which it was attached to other bodies; the upper valve is also much larger; the margins of the valves are regular and not sinuous; the height of the shell always much exceeds the lateral diameter, sometimes in the proportion of 6 inches by 3; it is nearly, and in some instances perhaps altogether, destitute of the deep sulcation and large lateral lobe which distinguish the dorsal surface of the convex valve in the Cotteswold species. *G. cymbium*, Lam., is well exemplified in the figures of Goldfuss* and Buvignier†, the larger figure of Goldfuss representing the shell in an advanced stage of growth, in which it acquired a greater degree of elongation, the general outline constituting a tolerable resemblance to the object which the name indicates.

Another Gryphæa, associated in the same beds with *G. cymbium*, and of which it may possibly be only a variety, presents a more near approximation to the Cotteswold species; it has a great degree of flatness and some irregularity which reminds

* Petref. Germaniæ, tab. 7. fig. 3; tab. 85. fig. 1.

† Géol. et Paléont. Dép. de la Meuse, Atlas, pl. 5. figs. 5, 6, 7.

us somewhat of the true oysters ; it has also a lateral lobe and sulcus, but much less prominent than in the Cotteswold shell, the general elongated form resembling *G. cymbium*. M. Buvignier considers it to be distinct from *G. cymbium*, and has named it *G. Broliensis**.

The conspicuous sulcation and lobe which serves prominently to distinguish the Cotteswold shell, is a feature which in a more modified form is present in nearly the whole of the species of this subgenus, of which it constitutes one of the characteristic attributes ; for although the species of *Gryphæa* are more easily distinguished than those of the true oysters, there exists nevertheless a large amount of variation. The adherent species will be found to exhibit greater variability than the others ; it may consequently be inferred, that the variation of form is connected with the position which was accidentally retained by the attached shell. The Cotteswold *Gryphæa*, which exhibits a considerable difference of aspect, was frequently attached to another of the same species, the shells being clustered together in masses.

In conformity with precedents in similar instances, I dedicate our Cotteswold *Gryphæa* to the author who first figured it in the 'Geology of Cheltenham,' and whose labours have contributed so much to enlarge our knowledge of the fauna of the Oolite.

GRYPHÆA BUCKMANNI.

Syn. *Gryphæa cymbium*, Murch. Geol. Chelt. 1834, p. 10.

——— *columba*, Lonsdale, in Geol. Proceedings, 1835.

——— *cymbium*, Morris, Catal. Brit. Foss. p. 109, 1843.

——— *cymbium*, Geol. Chelt. 2nd edit. 1845, p. 75, pl. 7. fig. 3.

Sp. char. Shell transversely ovate, very convex, irregularly and concentrically laminated ; beak acute, incurved, with a small adherent area ; larger valve extended laterally, inflated and bilobed, having a wide and deep sulcation which extends from the beak to the lower border ; upper valve concave ; margins of the valves sinuated.

The deep sulcation in the dorsal surface separates a posterior lateral lobe, which in the mature form has a diameter equal to a third part of the entire valve : in the young state the posterior lobe is but slightly developed, and the valves at that part are thin, but the groove is always conspicuous.

The species which most nearly approach *G. Buckmanni* are *G. dilatata*, Sow., and *G. controversa*, Roemer ; but these latter are much larger species, they are less inflated, and have the dorsal sulcation much more superficial.

* Géol. et Paléont. Dép. de la Meuse, Atlas, pl. 5. figs. 7, 8, 9.

Additional Notice of the genus Tancredia (Lycett), Hettangia (Turquem). By JOHN LYCETT, Esq.

READ FEBRUARY 1853.

At a meeting of the Cotteswold Naturalists' Club, held July 30, 1850, I had the honour to submit a memoir on the Testacea of the middle division of the Inferior Oolite, accompanied by a separate description of a group of small bivalve shells which occur both in that rock and in the Great Oolite. This group I proposed to erect into a genus, to be called *Tancredia*, a name intended to commemorate a gentleman no longer, unfortunately, a participator in our reunions. The fragility of the small shells which exemplified the genus, together with the coarseness of the investing stone, prevented my exposing the hinge of the left valve so clearly as could be wished; it was not therefore figured, and the description of the hinge in that valve was defective; but the hinge of the right valve, together with the external forms of three species, were faithfully rendered by Mr. Sowerby in the plate which accompanied the memoir. The 'Annals and Magazine of Natural History' for December 1850 contained the paper in question, and it was incorporated with the Transactions of the Cotteswold Naturalists' Club. The description of the hinge in the right valve was substantially correct, but owing to an imperfect knowledge of the form, arising from the valves being always found disunited, the term anterior was employed for posterior, and *vice versa*.

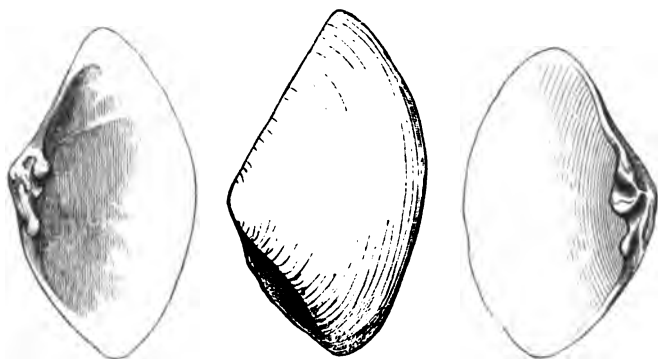
It is necessary to revert to these facts with precision, as during the past year (1852) a French author of eminence, both as a geologist and palæontologist, M. A. Buvignier of Verdun, has, in a new and splendid work on the geology of the department of the Meuse, figured and described certain species of *Tancredia* under the new generic name *Hettangia*, a name which he states to have been chosen by M. Turquem, the discoverer of the genus. The very superior manner in which the figures of that work are executed leaves no doubt of the identity of the two genera; the five species which M. Buvignier has illustrated are from the Lias, and bear the specific names *Broliensis*, *Deshayessea*, *Turquemea*, *longiscata*, and *Raulinea*? They are all distinct from the oolitic species of the Cotteswolds. From this statement it is evident, that in the absence of any other notice of the genus, my memoir on *Tancredia* has a claim to priority, and the generic name which I have chosen should be retained. More recently three addi-

tional species have been ascertained in our Great Oolite, and the hinge-characters of a fine Inferior Oolite species have been developed: as the latter shell, from its superior size and the prominence of its dentition, constitutes a remarkable example of the genus, I propose to describe it in detail, premising that the same species, in a greatly diminished form, was figured in the plate which accompanied the memoir of 1850, under the name of *T. donaciformis*. The small figure there given represents the usual size of specimens obtained in the shelly freestone of Leckhampton Hill; the larger examples now to be described occur not unfrequently in the bed called Gryphite grit, at Rodborough Hill, near Stroud, a locality which has produced so many novel and finely-preserved testacea. Upon comparing the hinge of the new shell with that of *T. extensa*, which was figured in my memoir, the difference between them is found to be considerable, and it requires a close scrutiny to perceive that the parts and their arrangement are alike in both, modified by the more advanced growth of the larger shell, and still more so by the peculiarities of the species.

The dental characters of *T. extensa* have much less prominence; they project but little vertically, and are more extended longitudinally. A similar difference is observable between the species which M. Buvignier has figured: his *T. Broliensis* in its hinge approaches to that of our large shell; but the hinge of his smaller and more elongated species, *Deshayesea*, presents a near resemblance to that of our *T. extensa*; the greater obliquity of the cardinal tooth in the elongated species is strongly marked, more especially in the left valve. The Rodborough examples of *T. donaciformis* may be regarded as representing the hinge-features in an exaggerated form, the result in some degree of greater age, inasmuch as smaller shells from the same locality lose much of this prominence of character. There would seem to exist much variability in the margins of the valves: all the specimens figured by M. Buvignier have a considerable aperture at the truncated posterior border; our Cotteswold examples present this character much modified; it is however very evident in *T. donaciformis*; but, strictly speaking, the borders of the valves are not close-fitting along their extent.

The fact that four, and perhaps five, species of *Tancredia* have been obtained in the Lias of France, will, it is trusted, induce collectors to examine the same formation in Gloucestershire with increased attention. M. Buvignier does not record the genus in the Oolites. In England it has hitherto been recognised only in the lower oolitic system, which would appear, from the work of M. Buvignier, to be very partially and inadequately represented in the Department of the Meuse.

TANCREIDIA DONACIFORMIS.



Sp. char. Shell subtrigonal, transverse, rather depressed, pointed at the extremities; umbones mesial or antero-mesial, small, depressed; anterior side attenuated, its superior margin rather concave; posterior side truncated and gaping, its margin straight, posterior to the ligament, and sloping obliquely downwards; an angle extends obliquely from the umbo to the infero-posterior extremity; ligament short, external, horizontal; margins of the valves not close-fitting and rather irregular.

Upon the principle that our choice of the typical example of a genus should comprise the several peculiarities of the form in a conspicuous manner, I prefer to select the present species to illustrate *Tancredia*, and will adopt its hinge-characters in the following amended description:—

Hinge with an obtuse cardinal tooth in each valve, which is received into a corresponding cavity in the opposite valve; there is also occasionally in the right valve a small anterior, and in the left a small posterior, accessory tooth upon the elevated margin of the cavity; lateral teeth, one large posterior and approximate in each valve, that of the left valve projecting, and received into a depression formed by the tooth or callosity of the other valve. Muscular impressions oval; pallial impression simple, faintly marked. There is no lunule: the margin of the right valve anterior to the umbo forms a thickened projecting fold which covers the tooth of the other valve, and is received into a corresponding receding portion of the margin of that valve, so that the junctions of the valves anterior to the umbones have a sinuous flexure. The lateral teeth are remarkably large in our typical species; they are never altogether absent, but are much depressed in some other species; and when this variation occurs in connexion with a de-

pressed, oblique, and elongated cardinal tooth in the left valve, the hinge is much altered in its aspect: the variation is exemplified by several species which occur in our Great Oolite and in the Lias of the Meuse.

The small accessory cardinal teeth are very uncertain in their distinctness, and constitute only a minor and variable feature.

The figure of *Tancredia* varies according as the anterior or posterior sides are the most produced; several species have the posterior side very short and convex, the figure then nearly resembles that of the recent *Donaces*: all the species hitherto discovered are destitute of ornament, they are remarkably smooth, and exhibit but indistinctly the lines of growth.

The number of species now known afford sufficient data for comparison with other genera, and to determine its position in the malacological system. To existing genera it would appear to be only remotely connected; but there are certain fossil forms, as yet insufficiently known, which seem to approach to it in several particulars; but whether these latter forms, which are associated with *Tancredia* in the same beds, are entitled to a position distinct from existing genera, remains to be determined. M. Buvignier has only indicated the position of *Hettangia* by placing it with the *Cardiaceæ*.

Remarks on the Lias at Fretherne near Newnham, and Purton near Sharpness; with an Account of some new Foraminifera discovered there; and on certain Pleistocene Deposits in the Vale of Gloucester. By the Rev. P. B. BRODIE, M.A., F.G.S.

READ 3RD MAY 1853.

I AM afraid that the few observations I have to offer on the strata and fossils at Fretherne Cliff will present little novelty or importance; still there are a few points of interest to which I wish to draw the attention of our Members, and which seem to deserve a short notice. The Lias here rises in the shape of a low cliff at the end of a round hill between Saul and Arlingham. You are aware that the Severn in its course below Longney makes a great curve, so that the low lands in this district are bounded on three sides by the river, but the generally flat aspect of the scenery is relieved by the picturesque and bold outlines of the Oolitic hills on the east and south-east, and the Palæozoic system of May Hill and the Forest of Dean on the west and north-west. There are several cliffs on the banks of the Severn where the Lias is exposed between Gloucester and Aust Passage. Westbury is, I believe, the first of these below Gloucester, which I have already described (Fossil Insects, p. 58), but most of them exhibit the lowest beds of the Lias resting on the Red Marl, and contain a peculiar and on the whole distinct assemblage of organic remains. To this Fretherne and Purton form an exception, as the small sections exposed there consist of the lower Lias overlying the "Ostrea bed," equivalent to certain other portions of the series in the Vale of Gloucester, as at Hatherly, the Leigh, Piffs Elm, Hardwicke, &c. The upper part of the former cliff is composed of several layers of grayish white and blue limestone, often nodular, divided by clay; and contains numerous fossils, viz. the characteristic *Gryphæa incurva*, *Lima gigantea*, *Gervillia*, *Avicula*, *Pecten*, *Nautilus*, *Ammonites*, spines and plates of Echinoderms, and a few other shells. The lower bands present the usual alternations of blue limestone and shales, which are often loaded with broken joints of *Pentacrinites*, amongst which a few heads of the rarer *Pentacrinites tuberculatus* (Miller) have been met with. This cliff, however, is particularly interesting,

from the occurrence of a new and fine species of the *Brachiopoda**, *Orbicula Townshendi* (named after the discoverer), and one of the *Foraminifera* which I lately found, and which Mr. Rupert Jones believes will prove to be a true *Nummulite*†. They occur in a particular part of the cliff near the centre, and seem to be confined to one or two bands of limestone, the weathered surfaces of which occasionally are covered with them, though, from the highly crystalline state in which these minute fossils are preserved, it is extremely difficult to make out their internal structure. This is the first occurrence of this genus in England in any stratum older than the Eocene (Tertiary) group, and was hitherto supposed to be confined to the Tertiary series. Ehrenberg proved long ago that many of these minute organisms among the *Foraminifera* (which form so important a part in the composition of many rocks), from the Chalk upwards, had continued to exist even to the present day, while the contemporary forms of a higher order had become extinct, and we may therefore feel less surprise at the presence of a true *Nummulite* even so low down in the secondary series as the *Lias*, although we have no trace of the same genus again until a comparatively recent epoch, a wide interval of time having elapsed between its supposed first creation and its reappearance in profusion in the Tertiary series. So abundant are some of these fossils in some places abroad, that vast masses of tertiary limestone are entirely composed of them, and in the *Lias* at *Fretherne* they are generally grouped together in masses.

M. Bouvigny has lately described and figured a *Nummulite*‡ from certain Jurassic strata on the continent, namely the lower marls belonging to the *calcaire à Astartes*, which occurs between the *Kimmeridge Clay* and the *Coral Rag*. I had previously observed similar forms in the *Lias* near *Down Hatherley*, but was ignorant of their true characters, for which palæontologists are indebted to the investigations of the able Assistant Secretary of the Geological Society, Mr. T. R. Jones, who has already described new and interesting species of *Foraminifera* from various deposits. My friend Mr. C. Moore of *Ilminster*, a zealous

* Mr. C. Moore has lately found several new species of *Brachiopoda* in the upper *Lias* in *Somersetshire*, and one very curious shell which he thinks may belong to a new genus, having two bosses at the aide. Deslongchamps has also detected several new forms belonging to this order in the upper *Lias* of *Normandy*, amongst which is a *Leptæna* of large size; all those previously discovered by Mr. Moore near *Ilminster* being extremely minute. See Mr. Davidson's Monograph: Palæontographical Society.

† See Mr. Jones's Note, *infra*.

‡ *Nummulina Humbertina*: see Géol. statistique, minér. et paléont. de la Meuse; Atlas, p. 47. pl. 31. f. 32-35.

and able collector and a good naturalist, informs me that although he has detected *fifty* new species of Foraminifera in the upper Lias and Marlstone of Somersetshire, he has never yet observed a *Nummulite*. The section at Purton is very small, but fossils are most abundant; it appears to be a little higher in the series than Fretherne Cliff, and is composed of clay and shale, in which are imbedded rounded blocks and nodules of blue limestone. *Gryphea Maccullochii* is very abundant, with *Pleurotomaria Anglica*, *Ammonites Bucklandi* (a fine specimen of which was discovered by Lord Ducie), a few of the *Nummulites* above referred to, and two other new and interesting species of Foraminifera. Some slabs of limestone are covered with many species of minute Univalves. It is at this spot that the Lias is succeeded by the Upper Ludlow rocks, which crop out on the banks of the Severn a little further to the west. I confess I have a great affection for the muddy Lias, as I am indebted to it for a rich store of insect remains. When I first came into this district, now twelve years ago, I carefully examined some of the beds of the lower Lias, belonging to the *middle* part of the formation in the neighbourhood of Gloucester, without success, and I was struck with the paucity of organic remains (which certainly are not numerous), although I have since then obtained a few rare and interesting fossils in them, especially elytra of Coleoptera, about three species of Corals, and Foraminifera having the appearance of *Nummulites*. After a time I visited Wainlode Cliff, where the basement beds of the Lias are exposed in a fine section resting on the Red Marl. There for the first time I discovered several wings and small wing-covers of Beetles in fallen fragments of limestone, which led me to search more closely, and the result has been a fine collection of wings, elytra, and a few entire insects from this division of the Lias, not only in Gloucestershire, but in Somersetshire, Worcestershire, and Warwickshire, where these insect beds are more or less extensively developed, and present many features of novelty and interest.

I subjoin a Note with which Mr. R. Jones has lately favoured me, since his renewed examination of these little fossils.

MY DEAR SIR,

The following are the characters of the minute bodies in the Fretherne limestone, as far as I have been enabled to work them out. They are discoidal, convex on both sides equally, $\frac{1}{4}$ inch in diameter, and $\frac{1}{8}$ inch thick in the centre. The surface is very coarsely granulated, excepting a narrow outside border on each face and the edge, which parts are but

slightly roughened. The granulation in some specimens follows irregular wavy lines from the centre of the disc towards the border; in others it is arranged somewhat spirally around the centre; more generally, however, it covers the central space thickly and irregularly. Between the smooth border and the granulated central part is a slight, narrow depression, which is stronger in some specimens than in others. The edge is rather obtuse.

When sections and transparent slices of these little bodies are examined, the whole body is seen to be coarsely crystalline; but by means of lenses of different powers and under a strong microscope several important indications of structure may be recognized. The horizontal sections exhibit internal spiral walls (which are not, however, in the specimens I have yet manipulated, traceable to the very centre), together with short, straight, cross septa, which latter are very visible in a weather-worn specimen from Purton. In the vertical sections are seen, on each side of the median line, the vertical tapering "columns" (originating in the local difference of structure in the shell tissue), characteristic of the Nummulite group, and traces of the central horizontal row of chambers. A line of fracture traverses this series of chambers, and sometimes brownish patches stain the calc-spar along this line; but the shape of these chambers is not satisfactorily shown.

I have not yet been able to recognize the apertures of connexion between the chambers nor the aperture of the last outer chamber.

The horizontal median line of chambers, spirally arranged, the vertical "columns," and the superficial granulations (which are continuous with the internal "columns") are characteristic of the true Nummulite; but unfortunately we do not know whether the position of the apertures of the cells in this little fossil corresponds with that in the genus just referred to. Provisionally, however, it may be regarded as a Nummulite; and, should you see no objection, it may be termed *Nummulites? liassicus*.

This form essentially differs from M. Bouvigny's *Nummulina Humbertina*, especially in external character and in size.

The three *Stichostegian* Foraminifers from Purton are *Dentalina*, belonging to two species. In shape one of them is something like *D. pauperata* (D'Orbigny), and the other approaches *D. Lorneiana* (D'Orbigny). To describe and name these fossils without figures would not be advisable.

I may here add, that some years since I obtained from a specimen of Lias clay from Gloucestershire some minute fossils which may be enumerated with the above, viz. a *Cristellaria* and

a *Vaginulina*, which were associated with the *Spirillina infima* and a few *Cytheres*.

I am, dear Sir, yours very truly,

T. RUPERT JONES.

The Rev. P. B. Brodie, A.M., F.G.S. &c.

Sept. 21, 1853.

I must now draw your attention to certain gravel beds round Gloucester, which have not been sufficiently or accurately examined, and which I hope some of our Members will shortly undertake to do. They are evidently of different age; one of the most recent appears to be the alluvial deposits on the banks of the Severn, of which the following section in descending order affords an example, and was given me by Mr. Edwards, one of the engineers of the Gloucester and Chepstow Railway.

	ft	in.
Soil	1	0
Sand and red clay	10	8
Light blue clay	13	9
Peat	2	0
Red sandy clay	4	0
Brown sand	1	10
Rough gravel	7	8
Sand and gravel	2	0
Fine gravel	5	10
Hard blue marl	2	3
Total.....	51	0

The above section was taken close to the Severn at Westgate (Over) Bridge. No shells are mentioned, but the thickness of the deposit is worthy of notice. The gravel round Gloucester is mainly composed of rolled fragments of Oolite and debris of Lias, and was evidently derived from the Inferior Oolite and Lias adjacent. Some pretty Oolitic Corals may be found in it, and occasionally bones and teeth of Elephant, Horse and Deer, but these are very scarce. During the excavations for the Great Western Railway at Stroud, many fine remains of Elephant, Rhinoceros, Horse, Deer, and Ox were procured from the gravel, and several of these are now in the collection of our friend and colleague Professor Buckman. The summit of Wainlode Hill is capped by a bed of pebbles called the Northern Drift, and is chiefly made up of rolled and rounded pebbles of ancient rocks and some flints, which have travelled from the north and north-east.

Another and very interesting deposit of gravel occurs in the

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neighbourhood of Westbury, which clearly owes its origin to the destruction of the Old Red Sandstone in the forest, and of the Silurian rocks of Huntley, May Hill, and Longhope adjoining. Among other things it contains many beautiful Corals from the Wenlock limestone. I had hoped to have been able to have investigated the Pleistocene formation generally in Gloucestershire, but unfortunately I have not had time to accomplish it, and I must therefore leave the task to abler and better hands. Of late these more modern accumulations have deservedly attracted the attention of geologists, and many interesting facts have been brought to light respecting them, and it is most desirable that they should be carefully examined and described in different localities.

As I am so shortly about to leave this neighbourhood, to my great regret, I may be excused, perhaps, in conclusion, for paying a parting tribute of regard to the geology of the district, to which I owe many days of health and happiness, and I can only say that I know of no other which presents so rich and important a field of research, or one wherein a diligent and active lover of science may reap a more productive or abundant harvest.

Within a circuit of twenty miles, nearly every formation, from the commencement of the lower Oolite down to the lower Silurian system, may be studied with comparative ease, and a good suite of fossils from each stratum may be collected. This, as many of you are well aware, comprises a very extensive series of rocks of vast extent and thickness, of great value in an æconomical point of view, and containing a varied and widely different fauna, by which we obtain a knowledge of the earth's history in past times, from one of the earliest ages up to a much more recent period.

The sorrow felt on leaving a neighbourhood so instructive in natural phenomena is increased by the loss of these pleasant meetings, and the parting with many scientific friends, whose companionship has added a charm and a zest to the studies of the closet and the more active labours of the field, and must ever afford a great encouragement in the pursuit of those noble ends and grand discoveries for which geology is so pre-eminently distinguished.

On some new species of Trigonina from the Inferior Oolite of the Cotteswolds, with preliminary Remarks upon that Genus. By JOHN LYCETT, Esq.

READ 19TH JULY 1853.

“ Not only by their numbers, but still more by the richness of their specific divisions, by the peculiar prominence of individualization, do the species of the remarkable genus *Trigonina* attain their maximum point in the lower chalk.”—L. VON BUCH, *Betrachtungen über die Verbreitung und die Grenzen der Kreide Bildungen*. Bonn, 1849.

TRIGONIA and *Pholadomya* are the two organic forms which pre-eminently serve to impress a distinctive character upon the Testacea of the Oolite rocks in whatever country they are discovered, and accordingly from the time when fossil shells were regarded as mere freaks of nature, we find that authors depicted their *Hippocephaloides* and *Bucardites*. But conspicuous as is the position which *Trigonina* holds throughout the Oolites, the quotation above chosen, and the passages which immediately follow, are not the less true and worthy of notice; they evince the strong impression made upon the mind of a distinguished and veteran palæontologist by the remarkable prominence which the genus *Trigonina* holds amongst the Cretaceous Conchifera, both in its numbers and world-wide distribution, a prominence which appears not the less remarkable when we remember that the leading sectional oolitic forms of the genus had already nearly disappeared, and that a little higher in the series even the cretaceous forms exhibit a rapid diminution, until in the upper chalk a trifling remnant alone remains to indicate the forthcoming extinction of the fossil *Trigonina*, a loss which is not the less strongly felt upon a contemplation of the altered, and in some measure degenerated characters of the living species. But if the attributes claimed for the genus at the æra which immediately precedes the extinction of the Cretaceous species are well-founded, it will, I think, appear equally evident that at its primal æra in the earlier portion of the Oolitic system the genus had already acquired that prominence amongst the Testacea which Von Buch has so vividly described, and that the forms, dimensions, and ornamentations of the species were scarcely less characteristic and varied. Upon numbering the entire recorded

species of *Trigonia*, it will be found that about two-thirds are proper to the Oolitic rocks ; and although some little abatement must be made, for instances in which young individuals, varieties, or mere casts have been erected into distinct species, the predominance of Oolitic forms will remain, inasmuch as the Cretaceous species are not exempt from similar errors of augmentation. The inadequate manner in which the Inferior Oolite *Trigonia* have been illustrated, will appear, when it is stated that of the sixteen species recorded in the present paper, four only will be found illustrated in the range of English literature ; a fifth occurs in the 'Mémoire sur les Trigonées' of Agassiz, and two others are on the eve of being published in a 'Monograph of the Palæontographical Society,' leaving upwards of nine species unfigured, a number which will be admitted to be remarkable when we remember that M. D'Orbigny has only enumerated seven in his 'Prodrome de Paléontologie' for the Terrain Bajocien of the whole of France, and M. Agassiz twelve from the entire lower Oolite rocks of Germany, France and Switzerland. The present examination of Inferior Oolite species has been suggested by the frequent occurrence in collections of *Trigonia costata*, *clavellata* and *angulata*, or of shells bearing those names, pertaining to nearly the entire series of the Oolitic rocks of England and France ; the aspect of these shells is so varied and dissimilar, that they agree with each other and with the typical forms of those species only, inasmuch as the first portion is costated, the second clavellated, and the remainder have their costæ bent to form an angle.

M. Agassiz, in his valuable memoir on *Trigonia*, arranged the species into upwards of eight sections, some of which appear to be separated by distinctions so transitive that it is scarcely possible to apply them to a large number of specimens, except in an arbitrary and unsatisfactory manner ; a more simple arrangement here proposed will probably answer every practical purpose, and has at least the advantage of being more readily understood and applied ; the genus will thus form six sections, of which one, the Pectines, is recent only ; the five fossil sections consisting of the Costatæ, the Clavellatæ, the Quadratæ, the Scabræ, and the Glabræ. The *Costatæ* have a figure more arched than the other sectional forms ; they have smooth regular longitudinal ribs, which are separated from the posterior slope or area by a carina more or less prominent, but which, with advance of age, often becomes nearly obliterated ; this is the *marginal carina* ; the area has transverse striations which are frequently decussated by longitudinal plications, and by one or two, more prominent than the others, that which bounds the area posteriorly being the *inner carina* ; should a third carina be present between the two others,

it is the *median carina* ; the lanceolate space posterior to the ligament is always plicated or reticulated.

The *Costatæ* are remarkably prominent in the lower and middle Oolite rocks ; in the upper Oolites and lower portion of the Cretaceous series they diminish and almost disappear. The *Clavellatæ* accompany the *Costatæ* in their stratigraphical distribution ; in this section I would include the *Clavellatæ*, the *Undulatæ*, and the *Scaphoides* of Agassiz, all of which have their costæ divided into tubercles, serrations, or irregular varices which are disposed in rows, either concentric, oblique or excentric ; sometimes they are bent to form an angle after the manner of the *Goniomyæ* ; the links which connect the one with the other of these features are too transitive to allow of any clear sectional divisions when they are applied to a large number of species, neither will the differences of form afford any more certain guide. In the *Clavellatæ*, as in the former sections, a carina more or less distinct separates the area from the tuberculated portion of the surface ; the area is transversely striated and is never large ; the lanceolate post-ligamental space is smooth, except in certain subcretaceous forms, which have the space strongly costated, as in the contemporaneous *Scabræ*, to which they form a passage ; these are the *T. sulcataria*, Lam., *T. muricata*, Goldf., and *T. Lusitanica*, Sharpe.

The *Quadratæ* have the figure rendered subquadrate by the largeness of the area, the upper border of which is nearly horizontal ; its surface is flattened, and sometimes constitutes the larger half up the shell ; there is no marginal carina, neither is there any clear line of separation between the area and the tuberculated portion of the surface ; the *Quadratæ* are fewer than the *Clavellatæ*, which they seem to replace in the Cretaceous and upper portion of the Oolitic system ; *Trigonia nodosa*, Sow., is a well-known example. The *Scabræ* constitute a fourth and very natural section, which are distinguished not less by their figure than by the beauty and variety of their ornamentation ; their figure indicates a change from the usual figure of the genus ; it is crescentic rather than trigonal ; the oblique costæ are elevated and serrated ; they are continued across the depressed area, the separating carina (marginal) being replaced only by a smooth groove. The stratigraphical distribution of the *Scabræ* is equally characteristic ; they are exclusively Cretaceous, and seem to replace the *Costatæ* of the Oolitic rocks ; *Trigonia alæformis* and *spinosa* are examples. The fifth section, or *Glabræ*, are destitute of costa, rows of tubercles or of carinæ upon the area ; their sides have large longitudinal plications, and are nearly smooth ; *Trigonia gibbosa* and *affinis* are examples : this section, of which few species are known, has not occurred beneath the upper division

of the Oolitic rocks. The sixth section, or *Pectines*, is represented by the living species of our Australasian seas, in which both the form and ornaments of the surface differ materially from those of the fossil sections; the radiating crenulated costæ and toothed edges of the valves remind us of the *Lime* and *Pectines*; the very partial flattening of the posterior slope and general figure nearly resembles *Cardium*, but the internal characters have nothing peculiar.

In tracing the vertical range of the species throughout the Oolitic rocks, it will be found that the facts coincide with others which have been recorded respecting the range of species pertaining to the other leading genera of Conchifera; it is rare that a species ranges beyond a single formation; and when its existence was further extended, it occurs usually in the newer formation, as a variety only, and bearing a physiognomy readily distinguished from that of the typical form. The aspect of the genus seems to have undergone a very gradual but continuous change throughout the secondary formations, by which the sectional forms of the lower Oolites were modified in the upper Oolites, and finally disappeared as the *Quadrata* and *Scabra* of the Cretaceous rocks acquired prominence; finally, between the latter and the recent *Pectines*, there occurs a chasm not less zoological than stratigraphical, in which we lose the links by which probably they were connected.

In the discrimination of species, it is of importance to have correct ideas of the surface-markings which distinguish their young condition. In the *Clavellata* generally, the young shells have their concentric costæ continued across the area; the costæ are slightly tumid and projecting when they cross the position of the marginal carina: in several instances the young of this section have smooth undivided costæ, and such species as in the adult state have their costæ forming an angle or undulation, do not exhibit any trace of such a feature until five or more costæ have been formed. But if in the rudimentary condition we are often unable to distinguish forms which subsequently become widely separated, the individuals of a species are in their immature stage all alike; they exhibit no traces of that law which is afterwards developed to form varieties of a species. A common feature observable in the *Clavellate* and *Quadrata* which tends to mask the species, consists in a confused or reticulated disposition of the tubercles, which no longer form regular concentric or curved rows; the tubercles also become irregular in size, or they are partially flattened and confluent in the rows; it is not clear to what causes are to be attributed this unequal secretion of shell by the mantle at the lower border; it is however quite distinct from another and final change observable in aged shells,

when the mantle ceases altogether to secrete ornaments upon the surface; in the latter case a change occurs (sometimes sudden), in which the carinæ upon the area, and the tubercles upon the sides of the shell simultaneously disappear, the last-formed portion of the surface being altogether destitute of ornament.

The mineral character of the beds in which *Trigonia* occurs is very various; clays, argillaceous limestones, chalk, calcareous oolitic freestone, and shelly oolitic drift equally contain it, but the latter kind of deposit does not seem to have been favourable for its development; for although specimens are abundant the size is dwarfed, and by far the larger number perished in the earlier stages of their growth.

In England the oldest stratum which contains *Trigonia* is the Lias of Yorkshire, which produces the *T. literata*. Phillips records it in the lower, and Williamson in the upper Lias, but the same formation has not furnished a single example of the genus throughout the middle and west of England; in Switzerland and Germany the upper Lias has five species, none of which have been identified in England. In the Cotteswold Hills, *Trigonia* is first found in the beds of ferruginous oolite which immediately overlie the sands at the base of the formation, and which abound with *Ammonites*, *Belemnites* and *Nautili*, but the *Trigoniae* are not numerous, and are only of three species; in the freestone beds higher in the series, and which are so largely developed in Gloucestershire, some local deposits have many species of *Trigonia*, but the genus does not acquire any particular prominence; it is only upon reaching the ragstones of the upper division of the formation that we find *Trigonia* in abundance; there it is associated with a large assemblage of bivalve mollusks, and less commonly with Echinodermata and Corals, but in either case the impressions of *Trigonia* often constitute a large proportion of the entire mass of the rock.

The Inferior Oolite, in common with the middle and lower Oolitic rocks generally, contains, according to the present arrangement, two sections only of the genus *Trigonia*.

In the following descriptions of species, the references to such as have been before figured and described are given as concisely as possible.

COSTATÆ.

- Trigonia costata*, Lam. Var. 1. *costata*. Var. 2. *multicosta*.
Var. 3. *pulla*. Var. 4. *sculpta*.
T. costatula, Lyc.
T. exigua, Lyc.
T. tenuicosta, Lyc.
T. hemispherica, Lyc.

CLAVELLATÆ.

- T. striata*, Sow.
T. duplicata, Sow.
T. angulata, Sow.
T. signata, Ag.
T. tuberculosa, Lyc.
T. v.-costata, Lyc.
T. clavo-costata, Lyc.
T. Phillipsi, Mor. & Lyc. var.
T. subglobosa, Mor. & Lyc.
T. gemmata, Lyc.
T. decorata, Lyc.

Trigonia tenuicosta, Lycett, n. sp. Pl. IX. fig. 4 a.

Shell subhemispherical, moderately large, the anterior and inferior borders rounded, the posterior border slightly concave; umbones pointed, prominent and recurved; costæ very numerous, not much elevated, closely arranged, gracefully curved and almost united to the marginal carina; area very large, its surface forms a considerable angle with the costated surface of the shell; it has three carinæ, the median and inner of which are small but distinct, and finely striated throughout their length; the marginal carina is delicate, striated, rather acute and very much curved; the spaces between the carinæ are very finely reticulated, the lanceolate space between the inner carinæ is large and very finely reticulated.

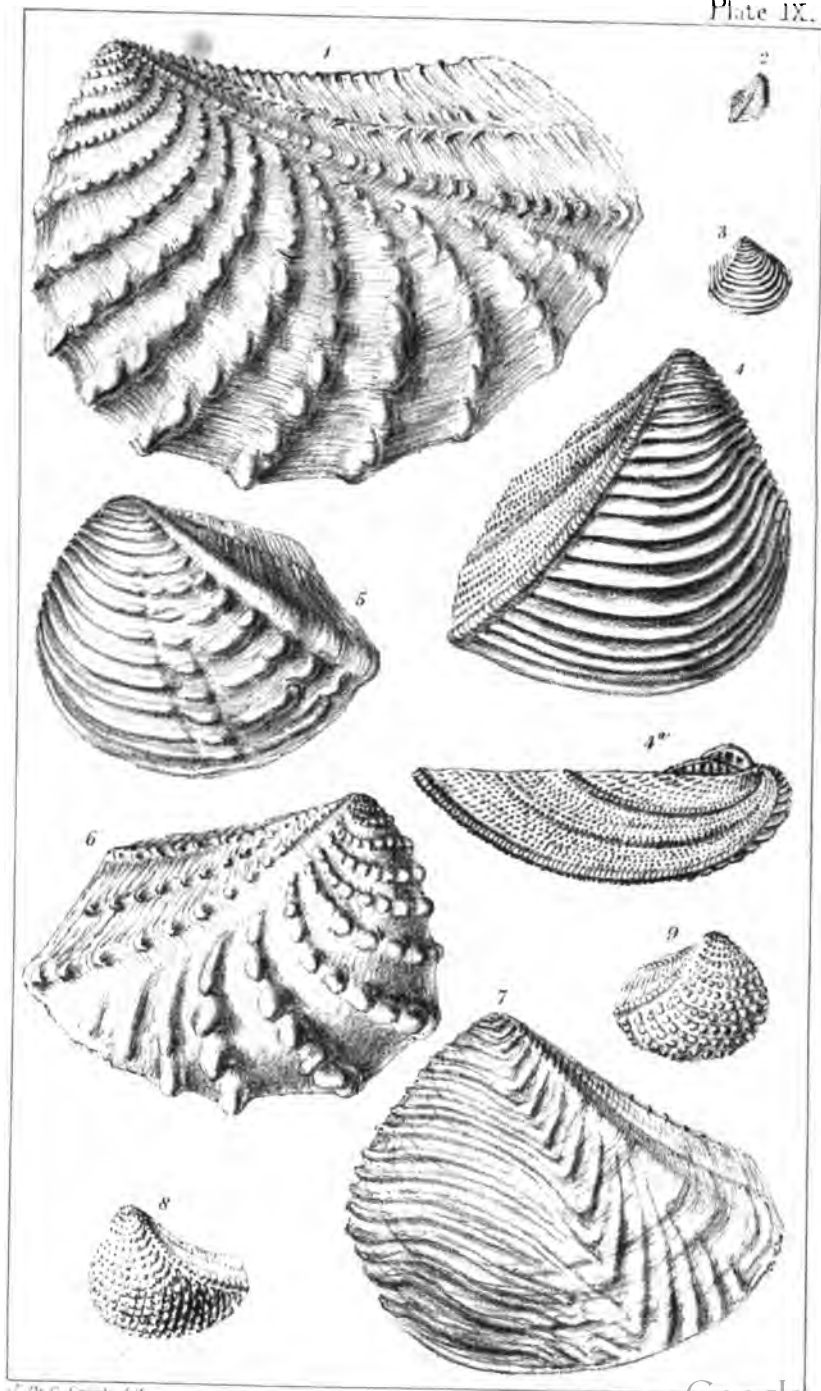
The great convexity of the valves and incurved figure of the umbones produces a considerable curvature in the marginal carina, and the costated portion of the shell near to the umbones is very narrow; the length of the marginal carina is somewhat greater than the diameter of the shell at right angles to it. From *Trigonia costata* it is distinguished by the more acute recurved apex, by the small and finely striated marginal carina, by the delicate and finely striated median and inner carinæ; the costæ are much more numerous, and are scarcely separated from the marginal carina; the entire form is smaller and unlike *T. costata*; the area is alike in both the valves.

It is somewhat rare; all the examples have been obtained in the upper division of the Inferior Oolite.

Professor Buckman has obtained it near Cheltenham; my own specimens are from the Gryphite grit of Rodborough Hill near Stroud.

Trigonia hemisphærica, Lycett, n. s. Pl. IX. fig. 2.

Shell small, its length not exceeding 3 lines, very much arched, so that the diameter through both the valves slightly exceeds the



length; the umbones are scarcely recurved, acute, contiguous; the area is large, flattened, forming a considerable angle with the other portion of the shell; it has numerous fine longitudinal plications faintly traced, there is no median carina, and the inner carina is very small; the marginal carina is acute, elevated and finely serrated; the other surface has numerous closely arranged longitudinal costæ, which are united to the marginal carina.

The large number of costæ and the characters of the area induce me to regard this as the adult condition of the species, notwithstanding the small dimensions.

A single specimen is my authority; it is from the bed of hard pale calcareous mudstone, a local deposit which in the Nailsworth valley replaces the bed of Oolite marl and abounds with *Nerinea*.

Trigonia costatula, Lycett. Pl. IX. fig. 5.

Trigonia costatula, Lycett in Ann. & Mag. Nat. Hist. 1850, p. 421.

Shell subtrigonal, convex; umbones mesial, not prominent nor recurved, anterior side produced and rounded, posterior side truncated; area flattened, finely striated transversely, divided longitudinally into two equal portions by a groove and bounded by two low carinæ; the marginal carina is imperfectly serrated, it is of moderate size and but little curved; the inner carina is nearly smooth; the space between the inner carinæ is smooth and very narrow or lanceolate; the costæ are numerous (about 21), moderately prominent and closely arranged; they are but little curved, are separated from the marginal carina by a plain surface, their direction being nearly horizontal or conformable to the inferior border. In the ultimate stage of growth the costæ posteriorly are broken more or less into several portions, which, however, continue to follow the general direction of the costæ. In the immature form the costæ are not separated from the marginal carina, and the area is traversed transversely by an equal number of prominent plications; but these gradually vanish, and the costæ become disunited from the carina, which then becomes serrated. The truncation at the posterior extremity is so considerable that the breadth of the area at that part is equal to half the entire length of the shell, or to three-fifths of the height; the length of the marginal carina is 20 lines.

The upper portion of the middle division of the Inferior Oolite has furnished the few specimens which have been procured; the locality is Scar Hill near Nailsworth.

Trigonia exigua, Lycett, n. sp. Pl. IX. fig. 3.

Shell small, subtrigonal, depressed; umbones mesial, not recurved, anterior border nearly straight, oblique, posterior border

truncated; area moderately large, flattened, transversely ribbed, and having an obscure oblique mesial furrow, no distinct carinæ, the marginal carina being replaced by a series of small nodulous elevations upon the posterior extremities of the costæ. Costæ smooth, curved, closely arranged, rounded, and slightly bent upwards as they approach the area, their number being about fourteen.

The costæ upon the area are smaller and rather more numerous, for an intercalated rib is sometimes added. Specimens vary from 2 to 5 lines in length, the latter dimensions seeming to represent the adult form.

From *T. costatula* it is distinguished by the much smaller dimensions and by the absence of any distinct marginal carina, the costæ being continued over its position upon the area.

Trigonia concinna, Roemer, Nord. Ool. Nachtrag. p. 35. tab. 19. fig. 21. approximates to our shell in the general figure and disposition of the costæ, but his shell would appear to have greater convexity and a larger area, and the costæ upon the area appear to be as large as those upon the other portion of the surface; it is therefore probably a distinct species.

Our little shell occurs not uncommonly in the shelly freestone of Leckhampton Hill; it has also occurred in the same beds near to Nailsworth.

Trigonia v.-costata, Lycett. Pl. IX. fig. 7.

Trigonia v.-costata, Lycett in Ann. & Mag. Nat. Hist. 1850, p. 422.

Shell ovately trigonal, moderately convex, anterior and inferior margins rounded, posterior margin straight or slightly concave; umbones obtuse, slightly recurved; area narrow, flattened, its upper portion transversely plicated, its lower portion nearly smooth, divided in its middle by an obliquely longitudinal furrow; marginal and inner carinæ but faintly marked and striated, the inner carina being crossed by several varices. The costæ are very numerous, smooth and regular, they are directed from the anterior border obliquely downwards and backwards nearly straight to the middle of the shell, and there form acute angles with varices which proceed upwards nearly vertically to the marginal carina; the varices are slightly nodulous, they are fewer and larger than the anterior costæ. The first eight or nine costæ form only curvatures, and are not broken into two portions.

The species which approaches most nearly to the present shell is *T. angulata*, Sow., but the figure of the two is different; the latter shell is more elongated and rostrated, the posterior border is much more concave, the umbones are more recurved, and con-

sequently the marginal carina is more curved and elongated ; the costæ are less numerous, less regular, and the varices are larger and more distantly arranged ; they form with the costæ rather an undulation than an angle, and are more conspicuously tuberculated.

In the young state the two forms would more nearly resemble each other, but even in that condition the costæ are more closely arranged in *T. v.-costata*. Some examples in the British Museum of a *Trigonia* collected by Miss Baker in the ferruginous Oolite of Northampton may be the young condition of the species ; to the same species may also be referred some small shells from the Dogger of the Yorkshire coast ; these have smooth, straight, oblique costæ, bent at a considerable angle, and have been labelled in collections *T. angulata*. The small *T. tripartita*, Forbes, from the Oolite of the Hebrides, has a certain degree of resemblance to our species, but the varices in that shell are fewer and much larger.

From *T. undulata*, From., our shell is distinguished by the less convex form and absence of large tubercles upon the marginal carina ; the arrangement of the costæ is nearly similar, but in our species they are much more numerous.

In the Cotteswolds *T. v.-costata* has occurred very rarely in the middle or freestone division near to Stroud, and my friend Dr. Wright has obtained two specimens in the ragstones of the upper division near to Cheltenham.

Trigonia decorata, Lycett, n. sp. Pl. IX. fig. 1.

Shell ovately trigonal, somewhat depressed ; umbones obtuse not recurved, anterior and inferior borders rounded, posterior border lengthened and straight ; area flattened, striated transversely, ornamented with three faintly traced carinæ, or rather as many lines of closely arranged very small regular tubercles, the inner carina having in addition at its upper part a few irregular transverse plications or varices ; there is also a median divisional sulcus, which passes parallel to the median row of tubercles upon the area. The clavellated portion of the shell has a very numerous series of rows of concentric tubercles ; the tubercles are small near to the marginal carina, and become larger towards the middle of the curvature ; they are distinct, rounded, closely arranged (15 or 16 being contained in a row), the number of rows being about twenty, the whole of which are distinctly tuberculated ; the lines of growth upon the sides of the shell are fine and distinct. The dimensions are equal to the largest examples of the clavellated *Trigonia*.

This elegant shell is nearly allied to *T. perlata*, Ag., which is

an Oxford clay species ; in that shell however the umbones are more recurved, the carinæ have much larger tubercles, and the median carina has in addition a series of transverse varices which are absent in *T. decorata*. It has sometimes been mistaken for *T. clavellata*, but differs from that well-known form in the following particulars.

The Inferior Oolite shell is less elongated, the umbones are not recurved, the posterior border is not concave, the general figure has less convexity, the area is more flattened, and the lanceolate space is much smaller and not striated ; the rows of costæ are more numerous ; the tubercles are more numerous, more closely arranged and less prominent. Another large clavellated species, the *T. muricata*, Goldf., approaches more nearly to the figure of our shell, but the Portuguese species has the area much more narrow, the costæ are less numerous, but much more elevated, the tubercles being larger and more distinctly arranged.

The figure likewise closely agrees with *T. Bronni*, Ag., from the Terrain à Chailles or Oxford clay ; but the ornamentation of our species, both upon the area and the sides of the shell, is more minute and delicate, with more numerous rows of costæ, the carinæ having no distinct elevation as in the species of Agassiz.

Trigonia decorata occurs abundantly in the Trigonia grit throughout the Cotteswolds, but the test is very fragile, and is difficult to detach from the hard matrix. Rodborough Hill near Stroud has produced it in great numbers.

Trigonia gemmata, Lycett, n. sp. Pl. IX. fig. 8.

Shell small, ovately trigonal, excavated and somewhat rostrated posteriorly, rounded anteriorly ; umbones obtuse, somewhat recurved, surface moderately convex ; area narrow, transversely striated and bounded on each side by a narrow, elevated and striated carina, which is also gracefully curled ; costæ numerous, closely arranged, elevated, acute ; the upper third of the valves has concentrically curved and finely tuberculated costæ, those which succeed are directed from the carina obliquely downwards ; they are straight, are regularly and densely serrated, the spaces between the costæ forming narrow deep grooves.

T. duplicata, Sow., approaches our shell in the general figure and in the arrangement of the costæ, but the latter costæ of *T. duplicata* are dichotomous and waved, the serrations being irregular ; neither of these features are observable in our shell.

It is very rare ; the largest specimen is an inch and a quarter in length upon the marginal carina, and an inch in the opposite direction. I have only seen two specimens.

Near Nailsworth, in the freestone beds.

Trigonia tuberculosa, Lycett. Pl. IX. fig. 9.*Trigonia tuberculosa*, Lycett in Ann. & Mag. Nat. Hist. 1850, p. 422.

Shell small, depressed, ovately trigonal; umbones recurved, anterior and inferior borders rounded, posterior border slightly excavated; area small, transversely striated, the striations being large and irregular; marginal and inner carinæ narrow, elevated and striated; the tuberculated costæ are numerous (18 in the adult), curved concentrically with very densely arranged tubercles; the tubercles are rather depressed, ovate or clavate, their longer diameter directed downwards.

A pretty little species distinguished from the young of *T. striata* by the more numerous costæ and by the peculiarities of the tubercles.

It is rare; for the present example I am indebted to the kindness of the Rev. P. B. Brodie, who has procured several specimens in the shelly freestone of Leckhampton Hill.

Trigonia clavo-costata, Lycett. Pl. IX. fig. 6.*Trigonia clavo-costata*, Lycett in Ann. & Mag. Nat. Hist. 1850, p. 425.

Shell subtrigonal; umbones obtuse, not recurved, anterior side produced, its border rounded, posterior border straight, oblique and truncated; area flattened, finely striated transversely and tricarinated; the marginal and median carinæ have regular moderate-sized tubercles, the inner carina has numerous transverse plications; the other portion of the surface is ornamented with a few rows of concentric tubercles; the tubercles are large, about eight in a row, the first two or three, and the latter one or two rows consisting of costæ which are not divided into tubercles.

Compared with *Trigonia decorata*, it is smaller and shorter posteriorly, the area has finer striations, the carinæ have larger and more distantly arranged tubercles, the concentric costæ have much larger tubercles; they are about half as numerous as in *T. decorata*; lastly, the few primal costæ are smooth, in the other species they are tuberculated.

A specimen in the cabinet of the author, and a second in that of Dr. Wright, are the only examples with which I am acquainted; they are nearly of equal dimensions, and agree in all their characteristic features.

Length upon the marginal carina $1\frac{3}{4}$ inch, opposite measurement $1\frac{1}{4}$ inch.

The building-stone of the Inferior Oolite which forms the upper portion of its middle division is the seat of this species, which has been obtained in the vicinity of Nailsworth.

*Trigonia costata.**Trigonia costata*, Lam., Sow., Zeilen, Deshayes, &c.Typical form *Costata*.

Anterior border truncated; umbones prominent, recurved; area slightly concave, with denticulated oblique plications, which differ in the two valves, the area of the right valve having two, three, or four large plications upon its anterior half, and no distinct median carina; the area of the left valve has a distinct median carina, and four or five plications upon each side of it; the inner and marginal carinæ are prominent and dentated, the latter separated from the longitudinal costæ by a depression; lanceolate space between the inner carinæ reticulated; longitudinal costæ slightly undulated, with a graceful double curvature resembling an elongated letter *f*.

Var. 2. *multicosta*.

This variety is much smaller than the typical shell; it is somewhat more depressed, its anterior border scarcely truncated, the area more finely reticulated, the costæ equal in number to the typical form, but more delicate and closely arranged; *multicosta* only attains about half the linear dimensions of the typical form; it has occurred only in the bed called Gryphite grit.

Var. 3. *pulla*. *T. pullus*, Sow.

This small variety occurs both in the Inferior and Great Oolite of the Cotteswolds; the larger specimens have a length upon the marginal carina not exceeding 20 lines, but few specimens are so large. The anterior border is not truncated, the carinæ and the intercarinal plications are prominent; in the Inferior Oolite it occurs in the freestone beds.

Var. 4. *sculpta*.

In dimensions this well-marked variety equals the typical form; in certain localities it occurs in the Gryphite grit in immense abundance; it is distinguished from the typical form by several conspicuous characters; the figure is less trigonal, the anterior border being destitute of any truncation; the umbones have less prominence and are less recurved, the area is larger, flatter, it is less concave, and occupies a much larger proportion of the surface of the shell; the marginal and inner carinæ are larger, less curved, and in common with the intercarinal plications, they are much more strongly dentated; owing to this prominence of the plications the median carina is much less conspicuous, the pos-

terior half of the area is more depressed than the anterior, so that a distinct mesial division is formed irrespective of the median carina. In the young state the median carina is distinct in each valve, but in progress of growth that of the right valve degenerates into one of the common oblique plications. The costæ are large and elevated, but they have not the graceful double curvature of the typical form.

This variety therefore differs from the typical form in its proportions, its general outline, and in the greater prominence of its surface ornaments; but the peculiarity which distinguishes the species in the character of its area is present in all the varieties, and serves to separate them from all of the allied costated forms.

Trigonia costata is stated to occur over the whole of Europe, and there is even a presumed variety of it from Cutch, figured and described by Mr. James Sowerby in the 'Geol. Trans.' vol. v. 2nd Ser.; it is, however, not improbable that a further acquaintance with the varieties of this shell and of allied costated species may lead eventually to altered views, both of their stratigraphical and geographical distribution.

The costated *Trigoniæ* from the lower Oolite of Switzerland, figured by Agassiz under the names of *T. lineolata* and *T. denticulata*, would appear from his figures and descriptions to be distinct from *T. costata*; the accuracy of the figures in the 'Petrifacta' of Goldfuss is exemplified in the fidelity with which the artist has delineated the area of the right valve in the young specimen, although its peculiarities are not alluded to in the description; the typical figure of Agassiz is correct, but it may as confidently be asserted, that the figure of the *right area* in the same plate has incautiously been transferred from the *left valve*, or it would have exhibited the peculiarities upon which I have insisted as marking the species.

Trigonia angulata, Sow.

Trigonia angulata, Sow. Min. Con. tab. 508. fig. 1.

Trigonia clavellata, Sow. Min. Con. tab. 87, the two lower figures.

Shell elongated and rostrated, posterior border concave, anterior border rounded; umbones recurved; area narrow, bounded by small crenated carinæ; costæ narrow, closely arranged, straight anteriorly, undulated posteriorly, where they form large tuberculated varices, the few last varices directed downwards. M. D'Orbigny (Prodrome de Paléontologie) considers *Trigonia undulata*, Fromberg, to be only a synonym of *T. angulata*: in this opinion I do not concur; the figure of the two shells is essentially

different, *T. angulata* being much more elongated, and the umbones more recurved; the surface ornaments of the shells likewise differ; those of *T. angulata* are remarkably constant and invariable.

T. undulata has not been recognized in the Oolites of England; on the other hand, *T. angulata* has not been discovered upon the continent. *T. angulata* has occurred at many localities in the Cotteswolds, both in the middle and upper portions of the Inferior Oolite, but it is rare. The imperfect specimen of *T. angulata* from Little Sodbury, which is given in the two lower figures of table 87 of the 'Mineral Conchology' as *T. clavellata*, has been the source of much confusion to subsequent observers, and has led them to catalogue clavellated specimens (usually imperfectly exposed) as *Trigonia clavellata*; but the figure in the same work of *T. angulata* is so characteristic, that it may be relied upon when the shell itself cannot be obtained for comparison.

Trigonia duplicata, Sow.

Trigonia duplicata, Sow. Min. Con. tab. 237. figs. 4, 5.

Shell slightly rostrated, area narrow, carinæ two in each valve, small, distinct; costæ narrow, serrated, the first few concentric, the others directed downwards, for the most part bifurcated and slightly waved. Should the *T. Proserpina* of D'Orbigny prove to be distinct from this species, it must possess peculiarities which are not alluded to in his 'Prodrome de Paléontologie,' where the brief description given agrees with *T. duplicata*. M. Agassiz (probably from an imperfect knowledge of the species) has placed *T. duplicata* with the *Scabræ*, but the very distinct marginal carina and the area destitute of transverse costæ clearly remove it from that section, which first appeared with the species of the lower greensand.

T. duplicata occurs in the upper division of the Inferior Oolite in the Cotteswolds, where the external impressions are not uncommon, but the shell itself is rare; it has also been found in the Great Oolite of Minchinhampton.

Trigonia Phillipsi var.

Trigonia Phillipsi, Mor. & Lyc. Gr. Ool. Monogr. 1853, tab. 6. fig. 1. p. 62.

Shell ovately trigonal; umbones submedian, obtuse, scarcely recurved, anterior border rounded, posterior border short, truncated; marginal and inner carinæ delicate, tuberculated and small; area narrow, flattened, striated, divided in its middle by an oblique furrow; sides of the valves with densely arranged, elevated, concentric, and finely indented or tuberculated costæ.

The present variety of the Lincolnshire shell, and of which I only know two examples, has the anterior portions of the costæ rather indistinct, and their junctions with the posterior and more curved portions form a kind of angle.

A more detailed description will be found in the monograph above referred to.

Trigonia signata, Ag.

SYN. *Trigonia clavellata*, Zeiten, Petref. Wurtemb. t. 58. fig. 3.

T. signata, Ag. Mém. sur les Trigonées, p. 48. pl. 3. fig. 8.

The most elongated and depressed of the *Clavellatæ*; the umbones are not prominent nor recurved; the area is lengthened, flattened, nearly smooth; carinæ nearly obsolete, rows of tuberculated costæ numerous, directed downwards, tubercles equal, scarcely separated, placed upon raised costæ.

Rare: position the lower or Ammonitiferous beds of the Inferior Oolite near Stroud.

Trigonia striata, Sow.

Trigonia striata, Sow. Min. Con. tab. 237. fig. 1-3; Agassiz, Mém. sur les Trigonées, pl. 4. fig. 10-12.

Shell somewhat depressed; umbones recurved; area flattened, bounded by two distinct narrow finely indented carinæ; costæ raised, numerous, concentric, deeply serrated, and varying in their number.

Trigonia Phillipsi, Mor. and Lyc. Gr. Ool. Mon. would easily be mistaken for this species, but the Lincolnshire shell is shorter, the umbones not recurved; the costæ are much less raised, more closely arranged, and so finely serrated as to appear smooth to the unaided vision.

Trigonia striata ranges throughout the Inferior Oolite of the Cotteswolds, and is abundant at Rodborough Hill near Stroud.

Trigonia subglobosa, Mor. & Lyc.

Trigonia subglobosa, Morris & Lycett, Gr. Ool. Monog. Bivalves, 1853, tab. 5. fig. 21. p. 55.

Shell nearly circular, convex; umbones recurved; area small, with three tuberculated carinæ; costæ large, closely arranged, angulated, their posterior portions forming a few large perpendicular varices.

It occurs in the freestone beds near Nailsworth; also in the Great Oolite: in both formations it is somewhat rare.

On the Cornbrash of the neighbourhood of Cirencester. By
JAMES BUCKMAN, F.L.S., F.G.S., Professor of Geology, Royal
Agricultural College.

READ 20TH SEPTEMBER 1853.

THE Cornbrash as it occurs in the neighbourhood of Cirencester, though for the most part a very thin member of the Oolitic series of rocks, yet presents us with many points for consideration of great interest.

In the counties of Gloucester and Wilts it is always found to rest upon a thick bed of Forest marble clay, a section at Kemble, four miles from Cirencester, being as follows in descending order :—

- | | | |
|---|-----|-----|
| 1. Cornbrash, an oolitic stone, with rough uneven fracture and full of shells | ft. | in. |
| 2. Blue clay without shells } Forest | 17 | 0 |
| Siliceous limestone ... } marble | 6 | 0 |
| 4. Bradford clay, very fossiliferous | 7 | 0 |
| 5. Great Oolite | | |

The bed No. 1, which it is our object to describe in the following remarks, though of so slight thickness, is found to be the substratum of large tracts of land, especially in the neighbourhood of Cirencester, Fairford, Cricklade, and Malmesbury; in each case presenting great and beneficial peculiarities of soil, not only when compared with that upon its surrounding forest marble, but also in comparison with other oolitic brashes; indeed, its name "Cornbrash" would appear to have been given to it from the fact that its soil affords a brash or stony soil favourable for corn crops, which is far from usually being the case with those either of the Inferior or Great Oolitic beds; indeed our observations of crops upon what the Cotteswold farmer calls "stone brashes" of the district, when compared with the Cornbrash, would lead us to conclude the following as a fair average grown upon an acre in bushels :—

	1. Stonebrash, Inferior Oolite.	2. Stonebrash, Great Oolite.	3. Cornbrash.
	Bushels.	Bushels.	Bushels.
Wheat	15 to 20	20 to 25	25 to 30
Barley.....	25 to 30	30 to 35	40 to 45
Oats	25 to 30	35 to 40	45 to 50

The average rent may perhaps be gathered from the following table:—

	the acre.
1. Stonebrash, Inferior Oolite	7 <i>s.</i> to 20 <i>s.</i>
2. Stonebrash, Great Oolite.....	14 <i>s.</i> to 25 <i>s.</i>
3. Cornbrash.....	20 <i>s.</i> to 40 <i>s.</i>

This great difference in the productive powers of soils, which a cursory examination only would lead to the conclusion were nearly alike in character, may, to a considerable extent, be explained by the following analyses, which were made by Professor Voelcker from specimens which I had the pleasure of procuring for him; and it may be remarked in passing, that as the analyses were made by the Professor in order to ascertain the different constituents of the rocks and not the soil, in each case typical hand specimens were presented to him, and the result singularly explains observed facts with regard to the crops upon the respective substrata.

Result of analyses by Professor A. Voelcker:—

	Inferior Oolite.	Great Oolite.	Cornbrash.
Carbonate of lime	89·20	95·346	89·195
Magnesia	·34	·739	·771
Sulphate of lime	·09	·204	·241
Oxide of iron			
Alumina	4·14	1·422	2·978
Phosphoric acid	·06	·124	·177
Soluble silica	2·75	1·016	1·231
Insoluble siliceous matter...	3·27	·533	4·827
Alkaline salts	undetermined.	undetermined.	undetermined.
	99·85	99·384	99·420

These analyses show that the phosphoric acid and sulphate of lime—two important chemical agents in the growth of crops—greatly predominate in the Cornbrash; and besides this, the thickness of Cornbrash soil is always greater than that upon the Stonebrashes, as this rock more readily breaks up and becomes disintegrated by atmospheric action.

These remarks tend to show the great practical advantage of geological and chemical knowledge, and fully explain how a successful farmer near Cirencester has converted a “brash farm”—which is in general a term of reproach—into one of the most productive farms in the district, this brash being the fertile Cornbrash.

But not only is this thin stratum of interest on account of the fine crops which it yields, but it will ever present a charm to the geologist from the rich harvest of fossils which it

everywhere contains ; indeed, the reason why it crumbles down so readily is probably owing in part to its being composed of shells, which are merely cemented together by a calcareous matrix, whilst the phosphates of the rocks are doubtless derived from its imbedded animal matter ; hence our examination has not only afforded a tolerable list of species, but several forms are numerically so great, and offer so many curious types, as to deserve a more attentive study than has yet been accorded them. Now in giving an account of the fossil contents of the Cornbrash, it must be understood that my facts are solely derived from observation in the quarries of my more immediate district and are consequently incomplete, and as a lengthened list of fossils could only be the more tedious the more copious its details, I propose in this place to append a mere summary of its remains, making remarks upon its more interesting palæontological features.

Summary of Cornbrash Fossils from the neighbourhood of Cirencester.

	Species.
1. Brachiopoda	7
2. Conchifera	30
3. Gasteropoda	10
4. Cephalopoda	3
5. Annelida	4
6. Zoophyta	3
7. Echinodermata	8
	—
	65

An interesting feature in the natural history of the Brachiopoda, is that five forms of *Terebratula*, namely the *T. lagenalis*, *sublagenalis*, *obovata*, *ornithocephala*, and *digona* of authors (see Davidson's memoir on Oolitic Brachiopoda by the Palæontographic Society), are all referable to one species ; this is a fact arrived at by a comparison of hundreds of individuals, and that the author just cited seems to have almost arrived at when he says, in his description of *T. lagenalis*, "This species has little to distinguish it from *T. ornithocephala*, into which it seems to merge by insensible passages," p. 42. As regards *T. sublagenalis*, the same author remarks, "This species is always accompanied by *T. lagenalis*, of which it may perhaps only be a variety," p. 43 ; and further, "It is not difficult to find species uniting *ornithocephala* to *lagenalis*, and this last to *sublagenalis* ; but as the typical shapes of each are well distinguishable, it will be found convenient to retain them under distinct specific names." The *Terebratula digona*, he says, "often approaches in general form and convexity certain specimens of *T. obovata*."

Here then a wide subject for discussion seems to be opened

up; for if we are to found specific names upon *typical* specimens, the question is, where are we to stop? certainly in the case before us, not with five species. And again, if we admit the specific identity of the five types under discussion, is it not probable that even these are but derivative forms that may, in like manner, be identified with others? Our own materials certainly tend to this conclusion.

In this district the five forms quoted, though not altogether, yet for the most part, affect distinct localities; hence the *T. la-genalis* and *sublagenalis* will be found congregated in masses in the Fairford quarries, while the *T. obovata*, from being a rare exception with them, becomes the rule between Cirencester and Cricklade. All these, however, are at Malmsbury replaced by the *T. digona*, which, as yet, is the only instance in this district in which I have observed the latter shell straying from the Bradford Clay, of which I have been used to consider it characteristic.

The only remaining Brachiopod I shall here mention will be the *T. intermedia*, 'Min. Conch.' t. 15. f. 8: this is undoubtedly, to say the least, a form of *T. perovalis*. This opinion again is borne out by Mr. Davidson, as he says in his Memoir, p. 53, "*Ter. intermedia* bears some resemblance to *T. perovalis*; some specimens are undistinguishable." Now as this latter is an abundant fossil of the Inferior Oolite as well as Cornbrash, the sequel will show its recurrence to be of great interest.

Our next remarks will be upon the Conchifera, the chief interest of which will be found in the fact, that in our summary of thirty species, twenty-one or two-thirds can be identified with Inferior Oolite shells, and those for the most part of individuals which have always been held as highly characteristic of the Lower Oolite beds; this will become apparent from the following

List of Fossils common to the Inferior Oolite and Cornbrash of Gloucestershire.

- | | |
|---|--|
| 1. <i>Amphidesma securiforme</i> , Phill.
York. (<i>Gresslya</i> .) | 12. <i>Modiola gibbosa</i> , M. C. |
| 2. — <i>decurtatum</i> , Phill. York. | 13. — <i>plicata</i> , M. C. |
| 3. — <i>recurvum</i> , Phill. York. | 14. <i>Mya literata</i> , M. C. |
| 4. <i>Astarte excavata</i> . | 15. <i>Ostrea</i> , undetermined (perhaps
several species). |
| 5. <i>Avicula inæqualvis</i> , M. C. | 16. <i>Pholadomya Murchisonæ</i> , M. C.
t. 545. |
| 6. <i>Cardium citroneideum</i> , Phill.
York. | 17. — <i>gibbosa</i> . |
| 7. — <i>dissimile</i> , M. C. | 18. <i>Plagiostoma duplicatum</i> . |
| 8. —, undetermined. | 19. <i>Pecten</i> . |
| 9. <i>Isocardia concentrica</i> . (<i>Ceromya</i> .) | 20. <i>Trigonia costata</i> . |
| 10. — <i>minima</i> . | 21. — <i>clavellata</i> . |
| 11. <i>Lima gibbosa</i> , M. C. 491. | |

Here then we have evidence of an older fauna reappearing in

force in a newer bed, and that bed of a very insignificant thickness; these facts, while they should make us cautious in assigning limits to the range of fossils, may at the same time account for much of the confusion felt in the history of the Oolites of Britain, which only becomes the greater on comparison with the "*Jurassique*" of the continent.

These remarks are the more pertinent, when it is understood that in Phillips's 'Illustrations of the Geology of Yorkshire,' nearly all, if not every individual species figured as characteristic of the Cornbrash are amongst the more common examples of Inferior Oolite fossils.

Now these species, except in a few instances, are not common alike to the Great Oolite of this district, but a reference to Morris and Lycett's 'Monograph of the Mollusca of the Great Oolite, chiefly from Minchinhampton and the coast of Yorkshire,' will tend to explain how the parallelism of the Inferior Oolite and Cornbrash species of this district could be maintained by the Great Oolite of the more northerly oolitic deposits. In the introduction to the memoir cited, p. 6, are the following remarks:—"The evidence afforded by the few species of univalves which have been forwarded to the authors from Scarborough, through the kindness of Mr. Bean, though not conclusive, tends rather to assimilate them with the Inferior Oolite, and the authors are led to the following very satisfactory explanation. Admitting therefore the parallelism of the deposits containing somewhat distinct faunas in the north-eastern and south-western parts of the present area of England, we are naturally led to infer, either that the physical conditions might be favourable to the continuation of species in one locality, or that species characteristic of an older deposit, in a more distant region, may have migrated and lived on during the formation of a newer deposit in another, the conditions having become unfavourable to the perpetuity of their development in the latter deposit over the original region whence they had migrated."

There is now only one other part of our summary of fossils which seems to claim attention, and that is the Echinodermata. Of these at least six out of eight are common to the Inferior Oolite, namely—

- | | |
|------------------------|--------------------------------|
| Nucleolites = Clypeus. | Holactypus = Galerites. |
| 1. — sinuatus. | 4. — depressus. |
| 2. — clunicularis. | 5. Acrosolenia hemicidaroides. |
| 3. — orbicularis. | 6. Diadema depressum. |

Of these the *Nucleolites sinuatus* and *Holactypus depressus* are highly characteristic of the Inferior Oolite.

In concluding these remarks, it should be understood that

they refer only to a limited district. Were our observations extended over the whole range of the Cornbrash, as it occurs in this country, we should doubtless arrive at additional facts, both as regards the structure and agricultural capabilities and also its fossil contents: we may indeed expect the list of the latter to be greatly augmented, and in all probability other species common to the Inferior Oolite will have to be noted in addition to those in our present list.

Remarks on Libellula Brodiei (Buckman), a Fossil Insect from the Upper Lias of Dumbleton, Gloucestershire. By Professor BUCKMAN, F.G.S., F.L.S.

As our associate, the Rev. P. B. Brodie, is leaving this district, I have much pleasure in calling the attention of the Members of the Cotteswold Club to the interesting discoveries of fossil insects from the Lias, which he has principally made within the limits of our more immediate operations, namely in the county of Gloucester; and this I think right to do now with the more immediate object of settling a question of nomenclature, and in order that our 'Proceedings' may perpetuate his name as attached to one of the most beautiful and perfect specimens he has yet discovered, to whom the following remarks will show that it was originally dedicated. In order to render this the more clear, it will be necessary to state that while Mr. Brodie was prosecuting his inquiries in the *Lower Lias*, in a band of which, termed by him the 'Insect Limestone,' he succeeded in exhuming remains of almost every class of Insecta, I had the pleasure of finding among others a fine wing of *Libellula* in a thin band of limestone in the *Upper Lias*: this discovery was announced to the Geological Society in a short paper "On the occurrence of Remains of Insects in the Upper Lias of the county of Gloucester;" and in vol. iv. part 1. page 211 of the 'Proceedings' of the Geological Society will be found the following remarks:—"The remains of insects comprise one species of *Libellula*, which, from the reticulations of the fine wing, seems to belong to the genus *Æshna*, and has been named by Mr. Buckman *Æshna Brodiei* in honour of Mr. Brodie."

Between this (June 21, 1843) and the publication of the 2nd edition of the 'Outlines of the Geology of the neighbourhood of Cheltenham,' in 1845, I had the pleasure of discovering another fine wing, and this and the previous one were first figured in that work, tab. 8. figs. 1 & 2, with the following description:—

"Fig. 1. *Posterior wing of Æshna Brodiei.*

"Fig. 2. *Anterior wing of ditto.*"

showing that I had arrived at the conclusion, that these two wings should both be referred to the same species.

However, later in the same year, Mr. Brodie published his

highly valuable 'History of the Insects of the Secondary Rocks,' in which work (pl. 8. figs. 1 & 2) the same wings are beautifully figured by Mr. Westwood, with the following explanatory remarks:—

"Plate 8. fig. 1. A remarkably fine wing of *Libellula*.

"Plate 8. fig. 2. An equally fine wing of an *Agrion*."

These at p. 101–2 of the same work are named—

"Fig. 1. *Libellula Brodiei*.

"Fig. 2. *Agrion Buckmanni*."

So that here we see that not only were these specimens doubted as belonging to the same species, but are positively assigned to distinct genera.

However, in 1848, Mr. Brodie's labours were rewarded by finding a most perfect *Libellula* in the same bed, with the four wings attached to the nearly perfect body. This unique specimen will be found figured in the 'Quarterly Journal of the Geological Society,' vol. v. pl. 2, and an examination of the fossil shows that the anterior wing is identical with that referred to *Agrion Buckmanni*, and the posterior to that of *Libellula Brodiei*; and at page 35 of the 'Journal' for 1848 is the following statement:—"According to Mr. Westwood, the wing figured in my work on 'Fossil Insects,' p. 8. f. 2, is not an *Agrion* as there supposed, but belongs to the same species as the one above described" (*Æshna Brodiei*, Buckman); and further, "Mr. Westwood considers that it will be better to adopt *Libellula* as the generic title, while the peculiar veining of the wings will form the ground for a provisional subgeneric one, which he names *Heterophlebia*; hence I propose provisionally to name it *Libellula (Heterophlebia) dislocata*, Brodie*."

Now it is quite clear that according to proper custom the specific name should not have been altered, so that, as the two specimens cited were after all found to resolve themselves as I supposed into one specific form, however my generic name might have been changed—for which I can see but little reason—yet the specific one should have remained intact. This beautiful specimen therefore should be designated as *Libellula Brodiei* (Buckman), as it was originally dedicated to the author of 'Fossil Insects' when even a single wing was one of the best insect specimens that had been obtained, and he is not the less worthy of having his name preserved for the perfect example. These remarks are made not only with the hope of correcting

* Brodie in Journal of Geol. Soc. vol. v. p. 35.

what I have deemed an error, but they may be useful as showing us how cautious we should be in founding genera from fragments: this is a most prolific cause of synonyms, with which no science is so overloaded as geology.

Cirencester, Sept. 1853.

Address read to the Cotteswold Naturalists' Club, at their Winter Meeting, held at Cheltenham.

By T. BARWICK LLOYD BAKER, Esq., of Hardwicke Court,
President.

GENTLEMEN,

Another year has passed over the Cotteswold Club—another year of joyous and instructive summer meetings—and again we have assembled at our winter gathering, with, ostensibly at least, the solemn purpose of a business meeting, for auditing accounts and levying taxes—somewhat relieved perhaps by a review of the pleasures and profits of the past year, which it becomes my pleasing duty to lay before you; and by such anticipations of the future, as may be given by our fixing on the localities to be visited next summer.

Five summers have now passed over our Club—and hitherto I think all will agree, that each succeeding year has brought us additional strength, prosperity, and enjoyment. Our numbers have increased to such a degree, as to compel us to throw almost churlish difficulties in the way of more admissions, lest we should become weakened by the very exuberance of our strength, and be obliged to relinquish one of the most agreeable of our habits, namely, the meeting in the small and unambitious hostelries of the remoter parts of the country, and be driven to seek accommodation for our increased numbers in the larger inns of the towns. While—with regard to riches—it is a fact well known to all political economists, that wealth is best evidenced by the amount of taxation; how greatly, then, has our prosperity increased, since we have risen from our first annual contribution of sixpence, to our present call of two shillings a head.

But let us commence our recapitulation of last year's proceedings.

On Jan. 22, 1850, our Club met for the winter gathering, on a truly wintry day, at Cirencester; and after breakfast proceeded to the Museum of the Royal Agricultural College. On our way thither, meeting Mr. Wilson, the Principal, he shewed us a deep cutting which was being made to lower a hill in the road behind the College, which, in spite of the frosty air, detained many of our geologists in a warm discussion. Thence, accompanying the Principal through the spacious Laboratory of the College, we found our kind and zealous friend, Mr. Buckman, in the Museum, in which, besides a good fire, were the numerous trays of fossils in their geological series. Through these he led us in one of his animated and instructive lectures, commencing with the *Enerinites Trilobites* and *Terebratula* of the Ludlow Limestone, when having arrived at the borders of the

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Lias, Mr. Brodie relieved him, and described the Insects of the Stonesfield Slate, which he had been the first to study and describe. He observed that most of the forms found in this formation were nearly allied to the recent genera now found in temperate climates, and it is probable that they, together with the plants which have been recently figured by Mr. Buckman, for the Geological Society, had been carried out to sea by large rivers for many miles. Mr. Buckman then continued the series by describing the Ichthyosaurus of the Lias and the great variety of Ammonites found in that formation—and it is on record that he promised us a paper on this interesting group—(and if the said promise be not redeemed, the sooner the Attorney General of the Club commences proceedings both for this and for one long promised on the mistletoe bough, the better, as his papers are far too valuable to be lost for want of exertion).

Mr. Brodie then did the honors of the Inferior Oolite, commencing with Mr. Strickland's section of Leckhampton Hill, and passing to the Great Oolite with its numerous Starfishes (the *Astropecten Cotswoodia*, (Buckman,) among others, which it was unanimously voted should be adopted as the Great Seal of our Club) to the Bradford Clay, (of which formation, be it noted, that the remains of between a hundred and fifty and two hundred species have been collected at the Tetbury Road Station,) and concluding with the Forest Marble.

After this our worthy Secretary, Sir Thomas Tancred, read us a resumé of the proceedings of the Club for the past year, the sites of our future operations were fixed, and the large sum of two shillings a head being voted as our annual subscription, we adjourned to dinner at the Swan; and in the evening Mr. Buckman read us his paper on the materials used in constructing the tessellated pavements at Cirencester (illustrated by his very beautiful coloured tracings of the pavements); and Mr. Lycett read another on the *Trichites*, a shell of the Oolite formation.

Mr. Wm. Henry Hyett, of Painswick House, and Mr. Wm. Vernon Guise, of Elmore, were then elected members, and the President and Secretary, it was agreed, should be permitted to try whether they could do better for the ensuing year than they had done for the last; and after some discussion on the inconvenience frequently occasioned by members not replying to the Secretary's notice of the meetings, and thereby rendering it impossible to know what preparations to make—it was voted, "*That if members do not answer the Secretary's notice they will not be expected; but that if they give notice of their attendance at any meeting and do not come, they shall be charged with such share of the Secretary's liabilities for the day, as the members present shall find necessary, unless they be prevented by illness or professional duties.*"

On April the 30th, we commenced the meetings of our fifth summer in the same spot in which we had first assembled to call our Club into existence, the (to us at least) ever-memorable Birdlip Hill. And, many as are the points of the Cotteswolds that we have

seen since we first met here, there is scarcely any from which is seen so well the field of our exertions and pleasures.

After breakfast the Club separated into two parties; the one a professedly botanical section—but mainly incited by a love of archæology—proceeded eastwards, towards Brimsfield, and the truly curious and beautiful church of Elkstone. But what they did, and what they saw, must remain unchronicled, as Mr. Bayly, who undertook to furnish notes of their proceedings, has not, I fear, performed his part, and their transactions are thereby lost to the world. Of the other section, however, it is recorded that they—leaving the south-westerly route, which was followed at our first meeting in July, 1846, to Witcombe Woods, the Roman Villa, and Cooper's Hill—now struck northward towards Leckhampton, and meeting Mr. Brodie near the top of the hill, and Mr. Lycett and Dr. Humble soon after, we had a most interesting discussion on the beds of the Inferior Oolite, which, though not seen here in any one section, may be examined in detail by following the Cotteswold range from S. to N. from the Great Oolite which caps the summit, to the Pisolite; and in one spot Mr. Brodie detecting the blue colour of the Lias, and some workmen's tools lying opportunely at hand, Mr. Wilson and Mr. Holland soon succeeded in uncovering sufficient to shew the junction of the base of the Inferior Oolite with the upper Lias. Returning, we followed the edge of the hill, crossing the valley of Crickley Hill, in the springs on the side of which we found many fresh-water mollusks, and several specimens of the newt or eft, *Lacerta Lacustris*. We returned to Birdlip in time to meet the rest of our party, now greatly increased, who, in the exercise of their botanical studies, had collected a large quantity of a species of agaricus, which was forthwith cooked *pro bono publico*; but, on its appearance at table, Mr. Buckman entertaining some doubt as to whether it was an edible or poisonous species, and having an argument thereon with some of his neighbours, the dish was detained till the point—and the fungi too—were discussed, when it was at length simultaneously decided that the mushrooms were wholesome and excellent, and that—the dish was empty.

After dinner we drank the health of the Berwickshire Naturalists' Club, on whose model we had formed our own Club on this spot four years before—and separated to meet at Gloucester, on the 18th of June.

On this day we met to breakfast at the Spread Eagle, at Gloucester, and thence walked to Mr. Brodie's, at Down Hatherly, to see—I will hardly say his collection of fossils, for that would have taken us nearer a week than a day to examine, but—such small part of it as the time would allow. We then saw the school—largely endowed by the munificent Mr. Page Wood, to whose unassuming liberality the county is in many ways deeply indebted (the state of the school reflecting great credit on its master), and proceeded to the banks of the Severn.

Wainlode Hill, our next point, is a small eminence on the bank

of the Severn, with an abrupt cliff, showing very beautifully in a section of nearly 100 feet in depth, the junction of the lower Lias with the upper beds of the new Red Sandstone.

Mr Brodie, in his work on Fossil Insects, has described the section of the upper part of this cliff—but as the paper I am now reading is intended solely for distribution to the members of our own Club—and its value, if there be any, is only that of a hand-book to portions of our own county—I trust he will permit me to copy it.

Beginning at the top, we find,	ft. in.
1. Black Clay (to the depth of)	3 0
2. Hard blue limestone, with oysters and other shells	0 4
3. Yellow shale, with traces of fucoids	0 10
4. Grey and blue limestone, "Insect limestone"	0 5
5. Marly clay	5 3
6. Hard yellow nubular limestone—with shells like <i>cyclas</i> a sp. of <i>renio</i> or <i>myacites</i> —Plants (<i>naiades</i>) <i>cypris</i> , and—rarely—scales of fish.....	6 to 8
7. Yellow clay	9 0
8. Black shale	3 0
9. Hard grey stone with impressions of <i>fucoides</i> in the upper surface, with scales and teeth of fish	0 1
10. Black Slaty clay.	
11. Pecten bed—a hard dingy brown stone, with much <i>Py-</i> <i>rites</i> , and <i>Pectens</i> and other shells	0 4
12. Black shale	8 0
13. Bone bed—here a hard thin stratum full of <i>Pyrites</i> , and composed of bones, scales and teeth of fish; connected with this is a white and yellow sandstone full of casts of <i>Palustra arenicola</i>	0 8
14. Black shale	2 0

This reposes on green and red conchoidal marl, forming the upper beds of the new Red Sandstone, exposed to the depth of about 65 feet. The total height of the cliff is nearly 100 feet, and the beds dip gradually to the S.E.—*Fossil Insects*, p. 58.

From the cliff we returned to Gloucester; Mr. Buckman, during our walk finding specimens of the *Lathyrus nissolia*, or crimson Grass Vetch, and some other plants of interest. We also saw, so far as any of us had observed, the first wheat of the season in ear.

At our after dinner proceedings, Mr. Buckman announced a new habitat for the *Thlaspi porfoliatum*, which had been discovered by Mr. Bell, a student at the Royal Agricultural College; this was in a Great Oolite quarry on the top of the Sapperton tunnel, and it was remarked that at its original station, at Burford, Oxon, and its other Gloucestershire habitat near Stow-on-the-Wold, from both which it is now said to be extinct, it had always effected this particular stratum of the Oolitic limestones. Mr. B. also made some remarks upon a new species of star fish, which he exhibited from the Great Oolite of Minchinhampton, which was observed to present an intermediate form between those previously described from the

lower part of this rock and those of the chalk. This specimen is now being figured by Professor Forbes, and what spite its discoverer—like the cross godmother fairies of old—could have taken to so interesting a species, I know not, but he would give it no better name than *Astropecten Bakeri*.

Mr. Brodie read us his observations made during a tour on the Oolite formation in Lincolnshire, comparing it with that which forms so large a part of our district.

A comparison of the fossils of the two districts lead to an animated discussion on the identity of the species of coral found in our Inferior Oolite, with those found in the same formation in Germany; diverging into a discussion on *the distinctions between species and varieties*, which was prevented from lasting to the present hour, only, by the threatened departure of the Cheltenham train, which dispersed our members for the day.

On July the 30th the Club made a second attempt (having failed in their first, four years before) to discover a specimen of fine weather in the Forest of Dean, and this time we succeeded admirably. Crossing the Severn, at Newnham, we breakfasted, and walked to the Churchyard, commanding a splendid view of the Horse-shoe of the river, and thence crossing the line of the railway, we ascended the Newnham Bailly, the ridge of which, covered with magnificent oak and beech timber, gives views on the one side of the rich and cultivated Vale of the Severn, and on the other of the dark woods of the Forest. Here Sir Martin Crawley Boevey and Dr. Bird, meeting us, guided us through the Abbots woods to the beautiful Sudeley valley, and the iron-stone pits at Shuckmantle, peculiarly rich in their ore, to a huge steam engine on the Cornish principle, erected by Mr. Crawshaw to pump the Lightmore coalpits. Mr. Crawshaw had kindly given orders not only to permit us to see all we wished, but had also provided us with some trucks and a pair of horses to convey us along the tram-road to near Bullow Pill, from whence we walked to Newnham to partake, *inter alia*, of a fawn, presented by Sir Martin Crawley Boevey.

In the course of the day Mr. Jones took a specimen of the *Strangalia attenuata* beetle. The *Scutellaria minor* was also gathered; and the *Polypodium oreopteris* and *Blechnum boreale* were found in large numbers.

In the evening Mr. Lycett's paper on the fossils of the middle division of the Inferior Oolite was read, in his much regretted absence, by the Secretary, and the Club adjourned with many thanks to the Gentlemen of the Forest who had so kindly assisted us.

On September 17, we met for the last time that Summer, at the Swan Inn, Wootton-under-Edge, and considering the distance from the homes of most of the Club we had a large attendance of members, besides many friends, who living in the neighbourhood, greatly assisted us by their local knowledge.

Ascending by the old road (now nearly disused but more favourable to Geologists from its deep cuttings than the new road)

to Rushmire turnpike, pausing awhile to admire the view, we turned to the left, by the grounds of the Ridge—the seat of Mr. Bengough—and crossing Waterly Bottom, ascended Stinchcombe Hill, from the summit of which—near Drakestone—Mr. Strickland gave us a most interesting Geological dissertation; shewing that the Welsh Hills had probably stood boldly forth, and far more loftily than at present, at a period when none of the rest of England had emerged from the waters.

It is most curious to observe how the sciences—even when not studied together—lead to the same result: but this is exactly the same conclusions, apparently, as has been arrived at by the students of Welch history, and fully accounts for the proverbial length of the *Welch Pedigrees*.

Returning by Stancombe and Nibley, we concluded our meetings of the summer of 1850, with Dr. Wright's account of his summer geologizing in the Isle of Wight, which appears in our papers: and Mr. Douglas Campbell proposed a scheme for a society for promoting botanical research to extend the knowledge of our own Flora.

And now, at the end of our year, let me again congratulate the Club on the progress we have made, not so much in the addition of fresh names to our list, as in the increased pleasure and interest in our pursuits which our members evince by their more frequent attendance. Our parties this year have seldom fallen short of twenty. Our papers have risen both in number and value, and I would fain hope that the facility which our meetings afford may have led some to take increased interest, and have afforded others increased opportunity for our great and noble study.

In addition to the two first objects of our club—namely, the obtaining some knowledge of our own county, and the general study of any branch of Natural History which each may prefer—it will be a great pleasure to us if we can assist in the carrying out of any more specific scheme for the study of any one branch of nature (such as that proposed by Mr. Douglas Campbell, of St. Chloe Grange, near Stroud,) for the better study of the flora of our own country.

The scheme appears well-arranged, and I hope that it may be taken up in such a manner as to ensure the success it deserves: yet, let me be allowed to say, that I hope, that if it be so, a resolution may be entered into by the Club, that—desireable as it may be to collect rare specimens—it would be most unworthy of the Society to encourage the spoliation of the nature which it professes to admire; and that the increased number of dried specimens of a rare plant, in collections, would be dearly indeed purchased by any considerable decrease of the same plant in its natural locality. *The greatest care should be taken when a rare plant is found, only to remove so small a portion of the total number, as not to risk any considerable diminution of its quantity.* (The cheering here was so loud that the opinion appeared to be unanimously adopted by the Club.)

And now we are on the subject, will you forgive me if I venture a suggestion upon collections in general?

The custom of *collecting* is now greatly on the increase, and the result, or perhaps the cause, is the increase of the noble study of nature; yet it is often to be regretted that the collection is commenced too vaguely, and without due consideration; in which case much of the labour is usually wasted, or at least misdirected, or even (which is not unfrequent) it is given up in disgust. Let us try whether we may not suggest the cause of this failure, and some rules for its avoidance.

Some half century ago *Collectors* and *Museums* were almost universally laughed at; and, I fear, in many cases most justly. A museum of that day (I speak, of course, not of the few collections of the truly learned, but of their unworthy imitators,) appears usually to have been a collection of heterogeneous objects, whose only interest consisted in their rarity, and the only pleasure contemplated by the possessor, was, the being able to say that he had got such and such things which others had not.

In these days happily a better taste is shewn; and Collectors now bring together objects, not for the mere sake of the possession, but with a view to the assistance which may be obtained from them in the study of nature. Now as more errors arise, probably, from mistaking the means for the end, than from any other known cause, let us constantly bear in mind that *the end*—the only end worth aiming at—is, the increasing our love and reverence to the source, the Creator of all nature, by gaining an additional degree of knowledge of Him through His works. One of the *means* to acquire this, is the study of any branch of nature to which our opportunities or our inclination may most dispose us, and one of the best *means* of pursuing this study, is the forming a collection which may enable us to familiarize our minds with its objects.

Commenced with this view, a collection becomes a matter of the noblest interest; while if commenced from the mere desire of possession, without any definite *end*, although it may, and often does, lead to study, yet until, or unless, it does so, in what degree is it superior to the practice of the tame magpie, who collects any objects which he considers curious, and with much the same end in view. Why should we wonder, then, when we see many who have begun without a definite object, throwing up their collections in disgust?

But if a collection is to be commenced solely as a *means* to assist ourselves and others—in the study of which ever of the wonderful and beautiful branches of nature we may select for our object—the more we can keep the *end* in view the more satisfactory is it likely to be. There are indeed few who can resist some degree of triumph or pleasure in the possession of a rare species, even though the species—barring its rarity—may be the least interesting of its genus; and this is to a certain degree desirable, inasmuch as it tends to ensure the preservation of the specimen; but a true *student* will guard carefully against the excess even of this feeling.

In forming a collection of any kind, we should begin by considering which of two great objects we prefer, and then make our selection

accordingly. Some prefer taking up some comparatively small department of nature, to study as it were, microscopically, as closely as possible: the humming birds or pigeons, for instance, among birds;—the papilionidæ amongst insects;—or the orchidaceæ or coniferæ of the vegetable kingdom;—while others prefer the larger field, and study ornithology, entomology, or botany in its wider range. It is not for me to say which is the preferable of the two (farther, than to hazard an opinion that the more minute student is more likely to be of service to others, while he who takes a larger field will gain the more pleasure and improvement for himself; that the first will be the more quoted as an authority; the latter will be the happier man) but it is at least most desirable that some care should be given to deciding which of the two lines we should take, in an early stage of our progress. If we take the wider range, we should endeavour to procure only two or three species of each genus, or even of much larger group, according to the facilities we are likely to have of collecting an equal proportion of all the classes, while in the latter case we may probably have a hope of nearly rendering our collection perfect, with some degree of fear least the unphilosophical triumph of being able to say “my collection is complete,” may supersede the quiet feeling of joy that we have so great *means* for the study of so great an *End*.

But in either case if we only commence the task of collecting—not with the spirit of a miser who enjoys the mere possession of the gold he cannot or will not use, but with the calm and philosophical feeling of one who rejoices in riches, for the sake of the good use he can make of them;—if we consider our collection not as end in itself, but simply as a means to facilitate in ourselves and others the study of nature—this great study in itself being regarded, the while, only as a means to lead our minds upwards from nature up to nature’s God. Then, indeed, it is that a collection rises in value and interest; nor is that interest likely to wane—nor the collection itself to be abandoned in disgust to the ravages of the damp and the moth—if it be based upon the same study which has called into existence and has hitherto given so much interest to the meetings of the Cotteswold Club.

POSTSCRIPT.

As this Address goes forth to the Great World (of the Cotteswold Club) without the usual concomitants of scientific papers, (Sir Thomas Tancred having—I think unfairly—robbed it of all the sugar plums lawfully belonging to it, to add them to his own address, which, like the good wine that needs no bush, had merit enough to have stood alone)—I think myself fortunate in being permitted to append the two following morceaux which—if not of the strictly scientific character usually displayed in our papers—shew at least the variety and scope of our studies in the learned languages.

The first may be taken as a model for the kind of application for admission to the Cotteswold Club, usually *expected* from the Candidates (we wish we may get—many such).

The second is especially valuable to the members of a Gloucestershire Club (though apparently not actually written by one of our members—what then—are we not to claim the *Astropecten Cotteswoldiæ* (Buckman) unless we prove that Mr. Buckman *made* it?)—especially valuable, I say, from its retaining in its purity a specimen of that noble and classical language formerly spoken in the Vale of Gloucestershire, ere the inexorable rod of a ruthless host of *English* schoolmasters had swept it from our country.

ODE. AD SOCIETATEM COTESVOLDIANAM.

Horatiusculus, apud Corinium, accessu inopinato podagræ agrotans.

ostracismo pendente, relegationem deprecatur.

Codice Latino

"Integer vitæ, scelerisque purus
Non eget Mauri jaculis, neque arcu,
Nec venenatis gravida sagittis,
Fusce, pharetrâ ;

Sive per Syrtis iter æstuosas,
Sive facturus per inhospitalem
Caucasum, vel quæ loca fabulosus
Lambit Hydaspes :

Namque me sylvâ lupus in Sabina,
Dum meam canto Lalagen, et ultra
Terminum curis vapor expeditis,
Fugit inermem :

Quale portentum neque militaris
Daunia in latissimis osculetis ;
Nec Juba tellus generat, leonum
Arida nutrix.

Pone me pigris ubi nulla campus
Arbor æstivâ recreatur aurâ ;
Quod latus mundi nebulae, malæque
Jupiter urget :

Pone sub curru nimium propinqui
Solis, in terrâ domibus negatâ ;
Dulce ridentem Lalagen amabo,
Dulce loquentem."

Hor. Od. xxi. l. 1.

caninè reddito.

Innocens vitis, cellar-isque purus
Non eget morbi pilulis neque haustu,
Nec podagrosos medico levanti
Fussy dolores ;

Sive permœstum via Minchinhampton, 5
Sive per Stroudæ loca jactitantis,
Painsvici alii, vel inhospitalis
Bisilis agenda est ;

Namque per sylvam mihi Michaelis,
Dum meos sector socios, et extra 10
Terminum fumis vapor expeditus
Default hostis :

Quale tormentum generant culinae
Gallicæ dulces epulas ferentes,
Aut merum fervens Paridis, podagræ 15
Humida nutrix.

Pone me in curru fugiente pennis,
Quatuor quales elementa præstant ;
Quod latus Glevi, Vapor aut benignus
Baker adoptet ; 20

Pone quâ docti coeunt propinqui
Montibus nomen Socii petentes ;
Dulce ridentes Socios amabo,
Dulce loquentes.

Sic, precor, quando venit Ostracismus 25
(Ut sit, et non in Sociis, *Hiatus*)
Ne cadat sævam renuens in urnam,

Calculus ater. H. H.

ANNOTATIONES.

4. *Fussy.*] Nominativo. Auctoripee.

5. *Sive per, &c.*]

"Mincing Hampton and Painswick proud,
Beggary Bisley, and strutting Stroud."
Urbes, ob Societatis in singulis con-
cursus, celebrandæ.

9. *Sylvam Michaelis.*] Anglicè *Michaelwood* per quam cum Sociis HH prius erraverat.

11. *Terminum.*]—Vise ferreo. *The Station.*

11. *Fumis.*] Ang: Steam.

12. *Hostis.*] *The enemy, gout.*

15. *Merum fervens.*] Gallicè *Cham-
pagne mousseux.*

15. *Paridis.*] Castigatiùs Lutetiæ.

16. *Humida nutrix.*] Ang. *the wet nurse.*

18. *Quatuor elementa.*] Ignis, aqua.
Terra coal, et aer steam.

19. *Vapor.*] Pro machinâ vapore impulsâ.

20. *Baker.*] Hujusce Societatis Præses dilectus.

21. *Propinquis Montibus.*] *The Coteswolds.* Inde Societas Cotesvoldiana

28. *Calculus ater.*] *A blackball.*

"Calculus immitem demittitur ater in urnam."

Ov. Met.

28. H. H. Horatiusculus Hiatus ?

Gloucester, March 22nd, 1851.

Mr.

Knowing what a condescendin good sort o genelman you be un as wat tha calls feel natral istory is a gettin verry popolar I teeks the liberty a sendin ya 2 or 3 little hannigotes a hannimals as I ha ad from time ta time in my passeeshun un hopes thayl proove uz emusin uz instructiv, uz we sais in our nayberhood, to your club. I kips a public at Kingshome un as my customers princely drops in ov a evnin bein a hous o call for jurnemen taylors un uther respectable treedsmen, in consekence my mornins beent verry much okkypied, un as I hallis ad a turn for observetion I a payd a good deal o tention ta what e calls dimestic hannymals un when you a yeerd my story I thinks youl say as how werry few poaple a livd on such hintimit terms we un, un consekently knauws moor about um, un so without funder preeface I shall enterr on my nurretion. About 12 mos ago I ad 2 pigs brothers un sisters thay was about 2 mos auwld when I had um fust un thay yused to run about o the kitchin un pic up tha crums ur watever else tha cud find in tha sheep o grub tul tha got 2 sassy, for my missis got az fond on um az if tha wus er auwn blessed babbies un let um do jest as ad got a minded un atween um bwoth we ad a verry nice time on it. If the missis wus a peerin tha teeters ur shellin a few peese tha rind un shells at last wuzent good enuf for um but thay must teek *thair* chalice afore we cud put by *our* whack out on um un thayd teek 1 anothers part so as we dussent saay as the ouse wus our auwn tul as I wus obleeged ta shet 1 on um up in tha sty We called one on um Jo un tother Sally. I thinks as jo wus tha sensyblest o tha 2 but Sally wus tha most mischievoussest un uz wee kep um seppereet why I shul giv you a count on um seperetly Jo kep a good deel ta do about bein shet up ut fust un yewsted ta cry un whine for all tha wuld like a babby wenever a seed tha missis un I thawt as her ad a pretty ny broke er hart cos I oodn't let her go un let un out but at last a got a kyind a reconciled like un begun ta look out for other emusement un what dy think a went un dun—why a begun bird ketchin. I ad a dyuse of a lot a robbins in tha garden un tha yusted ta cum un get at tha grains un uther hodments uz I yewsted ta put fur tha pig. I a sin 3 ur 4 ut a time a different parts a tha sty ut a time 1 a tha trauw, unother a top a tha raylings un tother a jiggig about a feared a tother 2, we a bit uf a fite atwizt um casionully. Wen Jo ad ad anuf ad yused ta lay down of is side jest uz eny uthur genelman mit do with is cheek jest a restin a tha side a tha trauw fur a piller un watch tha robbins.

Wen thur wus a bit uv a skrimmage among um ud look uz pleezd you can't think un grunt un sort a laff ta issell like tul 1 de a took it inta is yud to ketch 1 on um uz cum reether 2 neer toon, un skrumped un up jest like a nut. Well ater that a wus allis a bird ketchin un was up to all sorts a mooves at that theer geem. Ater a'd cleered out tha trauw pertty well a'd jest skatter about a feeaw grayns athin reach uv is nose, un lay down un pretend ta go ta

sleep, un then twaz warrhook ta any sparra or whitefinch or robbin ither uz cum athin is reech. But tha got up toot at last, un specially tha sparras; un then wot dy think a dun—wy a turnd to upon the Rots.

We ad all at once tha dyuce un all a rots, un wher tha cum from why Ime shure I dwont knauw, but awever tha seemed to use ta get ther prog princpally from tha pigs vittells.

Well, at fust, a seemed ta use ta like ther cumpney un wen tha did cum 1 or 2 at a time, a'd look quite plesed un stand un watch um un talk to um like jest as a used to do along a tha robbins but when tha birds got shire un tha rots moor numerouser un did cum $\frac{1}{2}$ a duzn ur a duzn at a time, 1 de quite onexpectedly a piches into um un massycrees 2 on um un ater that wenever a seed a likely chance heed fly at um jest like any uther reglar bred tarrier un a yused ta kip up them ther geems up ta tha de uv is deth wich took pleece soon ater a wus seeced for my rent wich somehow or nother unfortunatly got into rare.

Now as for Sally she wus allis of a weeklier constitution like as we ma say un dident thrive not neer sa well un so we yused for ta let her run in un out a tha taproom un bask afore tha fire along a tha ducks which I shal ave more ta say about them presenly but a got sassier nor ever Now ther was 2 or 3 fellas a mendin the rodes jest bi our ouse un 1 de tha cum in jest ta ave a pint a beer ath ther dinners wich was bred un chees or summut a that deskrypshun rapped up in ther ankychers. 1 on um appened ta put down ism for a minnit un I be hanged if Sally dident collar it un finished it (ankycher included) amost afore a cud say Jack Robison. Well ater that none on um cud leave a hankycher about or cum into tha house ath 1 in his hand but her must knauw all about it un see what a'd got in in but blessy a'd yused ta sarve we wuss nor that. Sumtimes when weed got a bit a beecon un greens or anything a that sort the missis ud teek up tha greens out a tha top a tha pot un put um upon the pleet upon the teeble fust (cos we allis likes um biled along a the beecon tha be so *much* richer) while her wus a getting out the beecon un I do assure you as if I wusnt standin sentry like all the time Ime blessed if that ther pig woodnt either jump up on his ind legs on the teble or else upset un un cler tha dish a evry teter or green as was in in afore a could well look round.

Now tha observation as I got to meek about that ther is as this here when a pet dog or amost any other sort a pet a dun anything a roguery he knows on it un'll cut away from e but a pig on't—he'll stand un grunt un snort un squeak at e like a bear un bully e out on't.

But a got sa mischievious at last as I coodn't kip un no longer a *did* offend so many a our customers un so I sowld un to a man at Santers fur amost nothin at all jest ta get rid on in—but I had ard work ta get tha missis ta part with un thauw.

Pon me life tha partin atwixt thay 2 wus quite outtin un a got out a is sty un cum un see us once or twice ater that. I dwont

know what ~~he~~ fed un on ater a left we but a'd got sa chalice then as a'd ardlly yet anything but bred un butter. The last I yeared the poor cretur wus as a'd died a very pertty pig a about a fourteen score.

Now thems what I considers very interesting hannygotes of a dimestic pig but them ther ducks wus 2 sech ducks as you don't see evry de barring as 1 on um wus a dreek.

Tha wus Mus-covys un wus give ta me by Dr. Wells a Nordon I never seed 2 kinder harted creeters in my life Tha meed themselves at home as soon as ever tha cum to us un after a bit tha got sa fond on us as wenever me or my missis went ta tha pump (not having no piece a water for um dy see) thay'd run jabberin up un woodn't let us go away or be at quiet tul weed pumped on um un geed um a good dousin un then thayd go in a doors un lay themselves down afore the fire to dry un if we offerad for to go away from the pump without doing on it for um thayd run ater us un peck our legs un heels a good un. I a got one on um now—the dreek—but Ime sorry to say as I lost tother about 12 Mos ago un you never see nothin more affectin nor the last moments o that ther duck.

Some time afore—some wicked rascal of a dog—how I wish I'd a ketched him ony praps I shoold a sarved him amost *too* bad—geed er a tightish nip l de un thow with a good deal a nussin un coddlin my missis brought im round again un a was got quite cheerful like a allis walked leem un limped a good deal un didnt seem to injay hisself so well as formly. Ater a bit a wuzn't so well agyan un seemed uz if there was summut az wazn't quite right in her inside. Well now my wife ad bin verry queer fur a wick or 2 with a bad complaint in her chest un one de tha duck seemed wuss nor ushal if anything un my wife was a nussin on her in her lap afore the fire un a seemed very thoughtful un all at once her says says her “I say Jem if I was to give the poor duck a dose a my medsan” says her “I shoodn't wonder if it didn't do un good for it have certnly done me a good deal” says her. And so “Well” says I “praps'tood. Ime agreeable” says I an so we geed un two teble spoonfuls a tha chest mixer. Well the poor creeter shook his hed un didn't seem to like it for a bit but at last a got quieter un seemed to be agwain off to sleep un all at once after a'd a layd quiet for about a ten minutes a tried to rouse issel up like un begun ta sheek is yed agean as if to say az twus no go—a give a fayntish queevering kind of a quack un then a looked up in my missises feece un died in a minnit. Now thats I considers a very interestin annygote of a Muscovy duck an its my firm belief as theres very few people as knows what affection dimestic animals may be brought to for um for want a treetin on um properly but all as Ive got to say about it is this here which is as if its of any use to you or the Cotsuld club as its verry much at your service un I remain Sir

Your humble servant to command
JEEMS NICKS.

PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' CLUB.

VOLUME II.

GLOUCESTER :

PRINTED BY N. PERRINS,
WESTGATE STREET.

1860.

CONTENTS OF VOL. II.

	Page
President's Annual Address for 1854	1 10
On Hand Bricks from the Island of Herm. By W. V. GUISE, Esq.	11 14
Notes on British Ferns. By Professor BUCKMAN	14 16
A description of some new species of Echinodermata from the Lias and Oolites. By THOMAS WRIGHT, Esq., M.D., (with figures)	17 48
Upon a new species of Alpheres discovered upon the Coast of Herm. By W. V. GUISE, Esq., F.L.S., F.G.S.	49 54
President's Address, 1855	i vi
Notes on the Natural History of the County of Gloucester. By Professor BUCKMAN	vi viii
On Fossil Echinodermata from the Island of Malta (with figures). By THOMAS WRIGHT, Esq., M.D., F.G.S., F.R.S.E.	55 117
On Perna Quadrata. By JOHN LYCETT, Esq.	118 120
On a new genus of Fossil Cidaridæ, with a synopsis of the species included therein. By THOMAS WRIGHT, Esq., M.D.	121 127
On some new species of Hemipedinæ from the Oolites. By THOMAS WRIGHT, M.D., F.R.S.E., F.G.S.	128 130
Note on the Subgenus Limea, Bronn. By JOHN LYCETT, Esq.	131
Remarks on the Inferior Oolite and Lias in parts of Northamptonshire compared with the same formations in Gloucestershire. By the Rev. P. B. BRODIE, M.A., F.G.S.	132 134
Notes on the Genus Quenstedtia. By JOHN LYCETT, Esq.	135 137
President's Address, 1856	i v
Inundations in Ancient Corinthum. By Professor BUCKMAN	v vii
Annual Address, 1857. By Professor BUCKMAN	i xii
Brief Notes on Cirencester High Cross (with plate). By CHARLES POOLEY, Esq.	xii xiv

List of Birds seen in Siddington, Gloucestershire. By EDWARD			
BOWLY, Esq.	..	..	xiv xvi
President's Address, 1858	..	..	i vii
Notes on Bisley Cross (with plate); also a Communication on			
Friar Bacon. By CHARLES POOLEY, Esq.	..	..	viii x
Notice of some Rare Bats from the neighbourhood of Gloucester			
and Cheltenham. By W. V. GUISE, Esq., F.L.S., F.G.S.			xi xii
Remarks on the Lias of Barrow, in Leicestershire, compared			
with the Lower Part of that formation in Gloucestershire,			
Worcestershire, and Warwickshire. By the Rev. P. B.			
BRODIE	..	..	139 141
On the Sands intermediate the Inferior Oolite and Lias of the			
Cotteswold Hills compared with a similar deposit upon the			
Coast of Yorkshire. By JOHN LYCETT, Esq.	..	..	142 149
On the discovery of <i>Cnicus Tuberosus</i> at Avebury, Wilts. By			
Professor BUCKMAN, F.L.S., &c.	..	..	150 152
Note on the presence of the Fossil Genus <i>Isodonta</i>, Bur in the			
English Jurassic Rocks. By JOHN LYCETT, Esq.	..	..	153 154
On some sections of the Upper Lias recently exposed at			
Nailsworth, Gloucestershire. By JOHN LYCETT, Esq.	..	..	155 163
President's Address, 1859	..	..	165 169
Notes on the Inferior Oolite Beds in the neighbourhood of			
Bath. By W. V. GUISE, Esq., F.L.S., F.G.S.	..	..	170 175
President's Address, 1860	..	..	176 197
On <i>Rhynchonella Acuta</i> and its affinities. By JOHN JONES	..	..	1 8

*An Address to the Cotteswold Club, delivered on January the
31st, 1854,*

By T. BARWICK LLOYD BAKER, Esq., President.

Eight Summers, my friends, I think I may say of enjoyment, and we will hope of improvement, to all of us, have now passed over our Cotteswold Club, and again at our Winter Meeting it is my task to lay before you a slight reminiscence of what we, as a club, have seen and done in the last two years.

Such a retrospect is usually made annually; but a circumstance occurred last year which, alas, threw us out of our usual course. I need not call on those comparatively few who stood, in July, 1846, on Birdlip hill, around Sir Thomas Tancred, who had called us together, and at his suggestion formed the plan of those pleasant rambles which, under his guidance, have given us for now nearly eight years some of the most satisfactory and enjoyable days we have spent—I need not, I say, call on those few, but I appeal to all who have since joined our gatherings, and have seen how his love of science and his constant good nature and attention to all have, up to last year held our club together—to say whether the loss of such a man was not sufficient to throw us out of our usual course, and excuse any breach of our regular routine.

True, he did not leave us without finding a successor. True, that that successor has supplied the place right well—and truly grateful are we to him for the zeal and kindness and attention he has shewn to us, yet I think that even Professor Buckman will be one of the first to join us in regretting the absence of Sir Thomas Tancred.

But let us lose no time in vain regrets, as we have much to do. On February the 10th it had been arranged that the Club should meet at Bristol. Many of us came down on the previous evening, and greatly enjoyed some hours spent at the house of Mr. King, the celebrated optician, in seeing a most interesting collection of Diatomaceæ and Desmidiæ, prepared by Thwaites, and beautifully shewn by one of the finest and most complete microscopes ever made for the reception of Ross's object glasses. The interest of these, and of many other curious instruments—among them the then new stereoscope—was much heightened by the kindness and the happy explanations of Mr. King himself, and it was late ere we returned to our inn.

The next day, after breakfast, we proceeded, under Mr. King's guidance, to a most curious old house, now a bookseller's, but formerly the residence of that princely merchant of Bristol, Canynge, the re-founder of that architectural gem of the old city, the church of St. Mary de Redcliffe, where we afterwards saw his tomb. The back part of the present shop was formerly a Chapel, or Oratory, and remains if unimproved, at least unspoiled; the floor, and a gallery half way up the walls appear untouched since

Canynges's day, as does the very small room behind it, which was probably the ordinary abode of the great merchant.

Thence we went to the Cathedral with its fine Norman Chapter room, the Mayor's Chapel with its encaustic tiles and gorgeous blazonries, and the newly decorated Merchants' Hall, and then spent an enjoyable hour or two—all too short, in the Park Street Institution.

Being here joined by several other Members of the Club, amongst whom, one of the principal was, alas, our deeply lamented friend Strickland, who brought with him his friend Mr. W. Saunders, a geologist of repute, and well acquainted with the country, we agreed, though our winter meetings are usually confined to the house—yet, as the day was fine, that we would explore the Gorge of the Avon, through whose magnificent cliffs of mountain limestone the river has apparently forced its way, presenting a series of geological phenomena, scarcely equalled for interest and grandeur. The varied arrangement of geological beds in this immediate vicinity, independently of the physical changes and contortions to which they have been subjected, renders the examination of the geology of the district highly instructive. Here we see the Mountain Limestone and Millstone Grit, at high angles of inclination, bringing up the Coal Measures, which are succeeded by the New Red Sandstone series and the Lias; and, at a distance of three or four miles, Dundry Hill presents its out-lying mass of inferior oolite. The latter indeed we did not reach, but returned from a longer ramble than our winter meeting usually permits, well satisfied though we made no greater discoveries to science than a *Conularia* in situ at the base of one of the cliffs quarried for road stone, which, so far as any then present knew, had never before been observed in that formation. If, however, we had done nothing to instruct or enlighten the learned of the land, it was something not to be despised, if we had in any degree enlightened ourselves by leading our own minds to thoughts connected with the great truths of nature. At least so thought simplehearted naturalists like—Strickland.

After dinner Mr. Jones produced his drawings of the hieroglyphics on the mummy presented by E. Hopkinson, Esq. to the Literary and Scientific Society at Gloucester. But Mr. Jones found that he had it not all to himself, for Mr. D. W. Nash, an active member of the Syro-Egyptian Society, having come to dine with us, a discussion on the interpretation of the hieroglyphs ensued; which had the effect of shewing to those ignorant of the matter, like myself, how very nearly two men who have separately studied even so abstruse a science as that of Egyptian hieroglyphs, may bring their interpretations to the same point.

On Tuesday, May 4, 1852, the Club met at Cheltenham, and, after breakfasting at the Lamb, proceeded, under the excellent guidance of Dr. Wright, for Southam, whence, ascending the hill to the Rising Sun, we turned to the right over the down of Cleve

Cloud, stopping a few minutes to look at one of the finest views in the upper part of the vale of Gloucester—wanting, indeed, the variety afforded by the broad estuary of the Severn, as seen from the hills nearer Bristol; but shewing most grandly the beauties of the upper part of the vale, with the Malvern and Abberley hills on the one side and Bredon on the other.

After a walk over the down, we reached the quarries above Postlip, but I fear that our Geologists found but little encouragement from a most unfossiliferous bed of freestone; while at Postlip itself we should have much more enjoyed the sight of a fine old mansion, (though now somewhat dilapidated and used as a farm house,) had we not been previously somewhat saddened by the sight of a once beautiful though small chapel, converted into a cow-shed. All the information we could get, was that "It hadn't been used as a chapel for twenty years, and, for aught they could tell, not for fifty." Thrice the latter period would probably have been nearer the mark.

Here we called a council of war, and agreed to form sections. The one party continuing their geological examination of Cleve Hill, on the summit of which they lighted on a somewhat peculiar bed of sand, while others walked on to Sudeley Castle, where, though from the absence of the kind and hospitable owner we were prevented from seeing the interior of the house, the exterior well repaid our walk.

After dinner was read,—alas, in Mr. Buckman's absence,—his interesting notice of a new sepistarium, obtained from the Lias Clays, at Cheltenham, remarkable as being so nearly allied to the true sepias of our present seas: thus differing widely from the *Belemnno-sepias*, or *Belemnites*, which are so abundant in the Lias. The present individual possessed a very perfect ink bag, which, with its tube, measuring about four inches, was full of the fossilized pigment, mineral sepia, from which drawings, illustrative of the specimen, had been made by Professor Buckman.

On the 22nd of June, we met at Fairford, in a great measure for the purpose of examining that most interesting collection of the corals found in that neighbourhood, by Miss Slatter, whose researches may yet throw a new light on the stratigraphical distribution of the rocks around Fairford. But the subject of corals is one which is wont to give rise to such long though highly interesting discussions, that, as we have plenty of work for this evening, the corals shall be left to their rest.

We next went to the church, whose magnificent windows of painted glass were most ably illustrated and explained by Mr. J. D. Thomas Niblet, whose long study of the subject makes us wish much that we had a more fully published account of the church from his pen and pencil. So thoroughly, indeed, is he "at home" here, that at one period the only direction by which a letter could find him was—J. D. Thos. Niblet, Esq., West Window, Fairford Church.

The site of the Fairford Saxon graves, situated about one mile

from the town, was our next point; but, as the investigations under Mr. Wylie have long been discontinued, there was but little visible evidence of those resting places of about one hundred bodies of our Saxon forefathers, whose remains, corporeal and ornamental, furnished Mr. Wylie with such curious evidence of the manners and customs, arts and manufactures, of the ancient Saxon race, as he has given us in his interesting volume, entitled *Saxon Graves*. A few beads, from a cottager, furnished us with a souvenir of the Saxon; some of pottery inlaid with strips of glass or enamel, others of amber. We know not whether this gum was supposed to possess any extraordinary charm, but it appears to have been much cherished by the Saxons, and the number of beads of this description found at Fairford would fill two or three pint measures.

On August 3rd we met in Gloucester and took the rail to Chepstow; a more scientific party may have occasionally met together, but not often a party more thoroughly disposed to enjoy an exquisite day amongst exquisite scenery. We started from Chepstow on a coach under the guidance of my excellent trooper, Jem Dobbs, of the White Hart, who drove us to within a short distance of the summit of the Windcliffe, whence we saw at our feet such meanderings of the Wye, that a cannon-ball would cross the river four times in its course to Chepstow Castle; while, if we raised the eye above the rock and wood of the opposite bank, it met the full range of the Cotteswold hills in the distance. Descending to the Moss Cottage, where we again found our vehicle, which descent was performed by some *viâ* the path with steps leading from the right of the summit, (where by the way we found the *Asplenium trichomanes*, growing in unusual luxuriance and beauty), and by others, more adventurous, who determined to find or make a way to the left, (by that extraordinary providence which the Musselman believes to attach to certain classes none were killed: Jem Dobbs still points out the scar of rock which one came down)—by right or left all finally arrived at the bottom and proceeded to Tintern.

I will not attempt to give any ideas of my own of this exquisite Abbey, but, as I in right of my office as President, claim the right of plagiarizing to any extent from the ideas of any of our members, a privilege of which I avail myself largely, often without acknowledging it, I will read Professor Buckman's ideas of it as slightly better than any I could give of my own.

An examination of its details must leave the following impressions upon a thoughtful mind:—

1st, The great economy of materials, every part being nicely adjusted to the work it had to do.

2nd, The complete absence of constructive ornament, its carvings are merely for the *ornamentation of some useful and necessary part of the structure*, and in no instance is anything unnecessarily obtruded so as to display ornament.

3rd, The ornamentation has been so nicely balanced, that the

whole structure strikes one as perfection ; presenting an unity of purpose which precludes the idea of what the Artist calls *spottiness*.

4th, The work has been executed with such exactitude and freedom of hand as seen in the capitals and bases of columns, in the window mullions, and the bosses of the groined roof, as at once must give us a lofty idea of the mechanical skill and the deep heartfelt emotions with which the artificer, no less than the designer of a sacred pile, were both actuated in past times.

The neighbourhood of Tintern is exceedingly rich in native plants ; amongst which the *Campanula latifolia*, *Hypericum androsæmum*, *H. montanum*, and *Euphorbia platyphylla* are remarkable. The geology of the Wye is of great interest, in the masses of old red sandstone conglomerate, standing out boldly on the banks of the stream, supporting the superincumbent mountain limestone.

Returning to Chepstow Castle, we spent an hour among its picturesque ruins, (observing, amongst other plants, that death-like parasite the *Orobanchæ hederæ*, or Ivy broomrape, growing from the roots of the Ivy,) and then returned to the White Hart, after examining and admiring the beautiful mechanical construction, though in no degree whatever admiring the picturesque beauty of that singularly hideous contrivance, the new railroad tubular bridge.

On the 14th of September we met at Gloucester, and proceeded in my break, which has gradually become dignified by the name of the Club Omnibus, to Huntley. Here we divided, and while some ascended May Hill, and enjoyed the glorious view we had before seen and attempted to describe, others strolled through the Silurian quarries of Longhope.

But, alas, there was a cloud on this meeting, which not the view from May Hill, nor the interest of the Longhope quarries could brighten. We were here to take leave of him who had first called us together, who first suggested the idea of the Club, and by his constant attention had hitherto held us together, and endeared himself personally to every member.

We will say no more than to be thankful for two things. First, that we have had several letters from him, speaking with delight of his new home, where we will sincerely wish him every happiness ; and secondly, for ourselves, that his place is filled by a successor in every way so desirable as Professor Buckman.

Our Winter Meeting took place on January 31st, just twelve months ago, at the house of your unworthy President, and glad indeed would the said President be to think that the day at Hardwicke afforded nearly as much pleasure to the members as their visit gave him.

We took a short walk, spite of wet and dirt, to the Reformatory School, which has since then obtained an amount of public notoriety little anticipated ; in which, by the way, I have managed somehow, unintentionally, to obtain for my own name the credit

due to that of Mr. Bengough, as effectually as I am in the habit of stating Mr. Jones's or Mr. Buckman's ideas in an address, and passing them off as my own.

As I am, by the way, addressing a Club composed principally of Gloucestershire men, I may perhaps be pardoned if I indulge in a little quiet county boasting; as it is not, I think, foreign to the purpose of our Club to notice the deeds of good men of our county. Hence we find that fifty years ago the gaols throughout the world were in a state that nowadays we cannot read of without much pain. I do not speak of the temperature being three degrees too hot or too cold, or the gruel too thick or too thin, but I speak of the days when sprigs of rue were laid round the prisoner in the dock; a custom still continued in many places for custom's sake, but then used in the hope of preventing those in court from catching the *gaol fever*, which arose from the filth, starvation, and misery, to which the prisoners were exposed, nay, on one occasion, chronicled as the Black Assizes, at Oxford, in 1577: *Baker's Chronicle*, informs us that "all who were present died within forty hours: the Lord Chief Baron, the Sheriff, and about three hundred more."

Howard, to whose name be all honour, drew public attention to the dreadful state of the matter, but it was reserved for a Gloucestershire Magistrate, Sir G. O. Paul, to invent a system which should remedy the evil. This system was first carried out in Gloucester gaol; thence it was taken to America, and, they said, greatly improved upon. It was tried in all parts of the world and improved upon everywhere, till at last, after fifty years consideration of the subject by all the world, after it had been improved upon till it was greatly altered from the original plan, the last great crowning improvement has been, to bring it back to nearly what Sir G. Paul first made it.

This, Gentlemen, I hold to be a triumph gained for Gloucestershire, by our excellent old Chairman, worthy of the notice of a Club who take an interest in all matters connected with the county. And perhaps it may be not without interest to remark that we do not appear to be retrograding, but that, as by Sir G. Paul's labours, who followed out the triumphs of Howard, Gloucestershire was the first county that possessed a good gaol, so by the energy of Mr. Bengough, who has followed out the system of poor Captain Brenton, Gloucestershire is the first county that has made adequate provision for the cure of its juvenile offenders.

Forgive me, Gentlemen, if I have said too much on this point, but the kindness with which you have frequently allowed me to digress has perhaps spoiled me.

From the School we walked over Acklow (or rather, I suspect, Oakleigh,) hill, to the lias quarry of Elmore, where the insect limestone was said to be opened to large extent; but, if I remember right it was in the south western pit where Mr. Brodie found the true bed.

Our dinner was marked by two circumstances—First, the

alarming announcement that, instead of our usual subscription of from one shilling to three and sixpence a year, a call was now to be made, amounting to fifteen shillings. When, however, it was remembered that we had paid no subscription the previous winter, we were somewhat pacified. When we thought of Dr. Wright's most valuable papers, which he had read, and the exquisite specimens he had produced to us of the *Pteroceras Wrightii*, and the Echinoderms, of which copies were promised us, we were reconciled; but it was not till the work was actually produced, on May 8rd, and we were able to estimate the credit accruing to our Club from the production of a work so valuable in its letter-press, and so beautifully illustrated, as Dr. Wright's care has rendered it, that we were quite happy.

The second, and more important, as well as more agreeable feature of the day was, that amongst our visitors was the Rev F. Symonds, of Pendock, a member of the Woolhope Naturalists' Club, and President of that newly established at Malvern; both clubs, we believe we may venture to say, formed on our model. If nothing had been seen or done on this day further than to make arrangements for the meeting of our Club, which took place on the 7th of June, and which laid the foundation, we trust, for many future annual meetings—that alone would have been sufficient to mark the day in the annals of our Club.

On May the 2nd, the Club commenced its summer rambles for 1853, at Gloucester, whence we proceeded by steamer down the canal to Sharpness. The weather certainly did not favour us, but it gave us a proof that the interest in the study of nature is not so dependent upon mere weather as many might suppose. It poured the whole day! We went in the cabin of the steamer all the way to Sharpness—we sat in the kitchen of the cottage nearly all the time we were there—and we returned in the cabin of the steamer. Yet interesting discussions filled up the greater part of the time; and particularly Mr. Buckman having crept out into the garden for a few minutes, under an umbrella, had collected a number of varieties of the common Primrose, which afforded us, from simple elements, and in simple language, a lecture such as Professor Buckman can give, revealing in a simple form some of the great truths of the physiology of the vegetable kingdom.

On the 7th of June was our great field day, on which we were to appear, I may say, in the very respectable position of fathers and grandfathers to the Clubs of Woolhope and Malvern. And well did the day turn out, to realize our best hopes, though, alas, a sad shadow is now thrown on our remembrance of it.

We of the Cotswold Club met at Gloucester, and, after breakfast, proceeded in the Club Omnibus to near Eastnor, where alighting and walking to the Valley of the White-leaved Oak,—(alas, the name is merely traditional, no white-leaved oak now existing)—we met Mr. Symonds and many members of the Malvern Club, and Mr. Lewis, the President, with a considerable

number of the Woolhope Club. Proceeding along the ridge of of that most interesting line, known as the Malvern Range, for some distance under the guidance of our lamented friend Strickland, it will long live in the recollection of those who enjoyed it, that he proposed a half hour's halt on one of the peaks, and, while we lay on the greensward around him, gave us such a brief but comprehensive lecture as few save Strickland could give, on the vast and extraordinary disruptions which, as far as human proof could shew, had caused the features of the exquisite landscape now spread at our feet: shewing how and at what period that wondrous cliff on which we stood was reared, which though now, from the washing away of its apex, stands but a few hundred feet in height, must at one time, in all probability have towered two miles in height above the Worcestershire vale, now stretched at our feet; while the latter, probably in those days and long after, was a broad arm of the sea, separating England from Wales.

Deeply as we lament our loss of such a man, endeared to most of us as a friend, as much as admired by all as one of the most eminent naturalists of the day, I cannot but for my own part rejoice that the last recollection we have of him was one so truly characteristic.

Proceeding through Lord Somers's Park, where we examined some of the Silurian beds, to the inn at Eastnor, (not having time, alas, to make a digression even to see the mistletoe in the oak, a short distance from the end of the ridgeway drive), we reached the inn, and dined, to the number of sixty members of the three Clubs; the principal feature of the evening being, I think, the appointment of a committee who undertook to draw up for us a Flora of Worcestershire, Gloucestershire, and Herefordshire. We trust that this may not be lost sight of. A most interesting paper on fishes of his county, was read by Mr. Whateley, and one by Mr. Lees, on the Malvern flora, and one by Mr. Davies, of Tewkesbury, on the natural history of the swallow.

On July 16, we again attempted the visit to Sharpness, the pleasure of which, if not altogether lost, had been sadly diminished by the rain; and this time we were more successful. After breakfasting at the Spread Eagle, at Gloucester, we embarked in the Wave steamer, which took us down the canal to Frampton bridge; from whence we walked accross to Fretherne Cliff, and returning to the canal proceeded by steamer again to near Perton Cliff, where the Lias and Silurian Strata appear in close proximity. From hence we walked by the grand works of the Basin at the mouth of the Gloucester and Berkeley Canal to Sharpness Point, a small pleasure ground of Lord Fitzhardinge's, which juts out boldly into the Severn, affording an exquisite view of the lower part of the estuary down to Bristol and Chepstow.

On August 16, we made a new experiment in our Club, and, emboldened by our previous success, we ventured to invite a large party of Ladies to our meeting at Cirencester. Alas! the weather was less propitious than our fair guests. The latter came in con-

siderable numbers, but the rain poured down without ceasing. Delightful walks through the Park had been proposed, but were clearly out of the question. Never mind. If people are blessed with good humour, and a determination to make the best of circumstances, they are not easily defeated. We went to the Church, where the kind Rector, Mr. Powell, occupied us well and profitably in shewing and explaining to us the highly interesting features of the building, which he has partially restored with excellent taste.

We then put ourselves under the guidance of Professor Buckman, to see the pavements discovered in the town, which he has so ably illustrated in his "*Corinium*," and which we trust will ere long be placed in a building now in actual course of erection, under the care of Lord Bathurst, (who, I am sure, will forgive the impatience with which the work is looked upon,) which will add a feature of so great interest to the town.

After seeing these, however, a couple of hours still remained to dinner, and the rain continued. We went to the Museum. Perhaps we may be forgiven if we say that the room had not the appearance of light and gaiety most captivating to Ladies. Nevertheless, Dr. Wright, who understands his subject so truly as to be never at a loss, taking his subject from a small collection of echinoderms, but branching from thence into the general principles of fossil zoology, gave us an off-hand but most interesting lecture, which, with a reply by Mr. Buckman, allowed us scant time to return to prepare for dinner.

After dinner the time was spent very agreeably, by examining a large variety of drawings and specimens, and listening to a very interesting discussion on the habits of the Hedge-hog.

On Sept. 20, the Club met to breakfast at Painswick House, by the invitation of our hospitable member, Wm. Henry Hyett, Esq. Mr. Gyde exhibited after breakfast a most perfect camera, for taking photographs, I think in less than five seconds. We then walked through the gardens to a beautiful collection of Ferns, which were flourishing as they are rarely seen to do in a newly planted collection, and returning to the house examined the stained woods for the successful preparation of which Mr. Hyett has long been celebrated, together with some trunks of trees, now in the progress of absorption. The process is interesting, independently of the staining of the wood, as presenting several new and curious features in vegetable physiology.

One party then went to examine the Quarries near the Horse-pools, while the remainder walked over Painswick Beacon, passing the spot on which it is recorded that the unhappy Charles stood with his sons, watching his army retiring from Gloucester, till the eldest being tired, begged him to go home, and the monarch made the sad but memorable reply, "My Sons, we have no home to go to!"

Leaving the grand encampment which crowns the summit, we proceeded to Pinknash Park, the seat of James Ackers, Esq.

where, in seeing his very curious and beautiful mansion, eating his excellent luncheon, and seeing his magnificent Hereford cattle, scarce time or appetite were left for the dinner at Painswick.

Forgive me, Gentlemen, that I have detained you so long, but as you have, alas, been shewn in the pecuniary affairs of the Club, when we miss the payment of one year the next is likely to fall heavy, so not having bored you with an address this day twelvemonth, you must now grumble as little as you can at a heavier infliction this year. If, however, I have not spared you, I think you will forgive a record of Meetings which, I may venture to say, have occasioned so much enjoyment as those of the Cotteswold Club.

On Hand-bricks, from the Island of Herm,

By W. V. GUISE, Esq., F.G.S.

In the course of a ramble amongst the Channel Islands, last summer, my attention was attracted by the unusual abundance of those "cairns" of stones, known by the name of "*Cromlechs*," which, in the little Islet of Herm, in particular, meet the eye everywhere, in the vallies as well as upon the eminences, and which, to the least poetical observer, lead the mind back to periods of dim and remote antiquity, when it might well seem that the vast Cyclopean masses around were

"Rear'd by the hands of giants,
In god-like days of old."

The exploring pick of the patient antiquary, however, speedily dispels these imaginings, and dreams of white-robed priests, and altars streaming with the blood of human victims, vanish before the cold realities of Truth, and the supposed temple, or altar, turns out, in every case which has been satisfactorily investigated, to be a place of burial, a vault or catacomb, which has, in most instances, been not merely the sepulchral chamber of an individual, but has been evidently used for the purpose of interment of many successive generations.

A vast proportion of those now visible (for many have been destroyed and all vestiges of them removed during the last century) have been explored by that able and indefatigable antiquary, Mr. C. F. Lukis, of Guernsey, whose papers, scattered through the earlier volumes of the *Archæological Journal*, have thrown so much light upon this obscure subject. In his Museum I first observed the baked clay clumps, or "Hand-bricks," as he calls them, which I have the pleasure of laying upon the table this evening; and during a short visit afterwards to the Islands of Herm I had an opportunity of investigating an almost inexhaustible hoard of the same singular objects, stored up in a manner and to an extent which would appear to defy the ingenuity of the most speculative mind to account for.

The site of this deposit in the Islands of Herm, is a sea-cliff of sand, about 40 feet in height, resting upon solid rock, the spurs of which projecting below, prevent the encroachments of the sea. The sole outward indication of the buried hoard is to be found in the appearance upon the surface of the cliff of extraordinary quantities of limpet shells, scattered in profusion over the sand, and which, taking their presence as a standard of measurement, would seem to manifest an extension of the deposit to the distance of nearly a quarter of a mile. It was the presence of these shells in such unusual abundance which first drew the attention to the spot of an intelligent fisherman, who had been employed by Mr. Lukis, in assisting him in his researches, who, connecting these shells with those found in such remarkable profusion in the

cromlechs which he had seen opened, was led to make excavations which resulted in the discovery of the vast storehouse of curious objects similar to those now before us.

The soft and yielding nature of the sandy cliff offers but little resistance to the pick and spade, and at the distance of little more than three feet from the surface, are found the baked clay clumps, to which have been given the name of "Hand-bricks," because, as will at once be observable upon inspection, they have been formed by simply moulding in the grasp a handful of kneaded clay, and then stamping the ends upon flat boards or stones, in which state they have been fired; and their surface still bears the imprint of the cuticle and fingers which were employed in their manufacture. They are found, not lying indiscriminately, but packed together with evident order, care, and arrangement, lying transversely over and across one another, and, at intervals, as if to support the weight and pressure, are placed a sort of rude flat bricks, shaped as if formed without a regular mould, but merely pressed together with boards; the length I was not able to ascertain, having failed in procuring a perfect example, but probably 14 or 16 inches. Associated with these is a great abundance of broken pottery, both baked and unbaked, mostly coarse and of the rudest manufacture, but here and there portions occur which bear marks of the wheel, and of more careful elaboration. I have unfortunately lost the only specimen illustrative of this fact which I possessed, but it was apparently sun-dried, and of finer clay than any of the examples now before us. Limpet shells innumerable are profusely distributed throughout the deposit, which, from age, have parted with their animal matter, and adhere more or less to the tongue. The accompanying stone* was disinterred at the same time; to which I draw attention, as it will be seen, upon examination, that it is not in its normal condition, but bears marks, in its bevelled edge and smooth surface, of having been subjected to friction, and made use of probably as a muller, in the manufacture of the clay for the accompanying pottery.

The old fisherman who was my guide attributed the fabrication of the "Hand-bricks" to the Druids, who, like other representatives of unknown powers, are occasionally made responsible for facts which cannot be referred to any known origin. Amongst ourselves, Julius Cæsar and "Old Scratch" divide the honour of similar ascriptions. Mr. Lukis, however, informs me that the period to which they may most probably be referred is the Romano-British or Gaulish, but that this point is doubtful and requires further elucidation.

It seems possible, indeed, looking to the isolated situation of these islands, that their inhabitants may have remained in a rude and barbarous condition, and have retained their primitive habits, uses, and customs, for a considerable period after the tribes in-

* The Stone here referred to, together with specimens of the Hand-bricks and Pottery, were laid upon the table at the time this paper was read, and are now deposited in the Museum of the Royal Agricultural College, at Cirencester.

habiting the neighbouring continent may have been converted to a more civilized mode of life. Thus it may not be impossible that the ancient processes of manufacture, together with religious rites and modes of interment, may have come down to a much later date than even the Roman occupation of the adjoining continent. We see instances in point now, amongst the barbarous tribes of the Polynesian Islands, who, in spite of steam navigation, and continual intercourse with more civilized nations, still cling to their axes of jade and arrows tipt with bone; and I have read, that, within the last century, Pagan rites were celebrated upon the Isle de Batz, and other islands upon the northern coast of Brittany.

The purpose served by these "Hand-bricks" would seem to be explained in some measure by their association with the broken pottery, which goes to substantiate the supposition that they were in some way used in the process of its manufacture, possibly as a sort of rude furnace, which would have afforded a means of economising wood, which is, and always must have been, scarce upon those rocky islets.

Mr. Lukis informs me that similar substances, that is "Hand-bricks" and "Pottery," have been found associated in Lincolnshire and in Romney Marsh—in the former place, it is said in company with Roman fictile vessels. In Herm, he states, that one fragment of true Samian ware was discovered in 1841. All this would seem to point to the Romano-British period, were it not that these same "Hand-bricks" have been found within more than one cromlech, associated only with stone implements of the rudest description. One such is mentioned by Mr. Lukis in his second paper on the *Primæval Antiquities of the Channel Islands*, in the 1st vol. of the *Archæological Journal*. The cromlech referred to was opened by him on the plain of L'Ancrese, in the northern part of Guernsey, in which he states, "He found many pieces of clay, of a peculiar form, from three to six inches in length, made by rolling a piece of clay in the hand, and striking each end against a board, and still bearing the mark of the inside of the fingers and impression of the skin of the maker." "With these," he adds, "were found no vestiges of any metal," "and the many rude stone implements found with them made it evident there were none then in use."

Hence arise doubts which can only be solved by further investigation; and when last I heard from Mr. Lukis, he informed me that he was about shortly to undertake the exploration of a hitherto undisturbed cromlech, in the hopes of finding further evidences to elucidate this intricate subject.

In conclusion, I have only to state that I am mainly indebted to Mr. Lukis, and to his published Papers, for any information I may have been able to lay before you this evening, which, under ordinary circumstances, I should hardly have ventured to attempt; but, as we number amongst us many who are interested in Archæological pursuits, I trust that the novel and peculiar nature

of the substances which form the subject of my communication this evening, may be held in some measure to justify me in bringing under your notice a matter, which, though not included within the range of Natural History, yet possesses in itself claims upon the attention and sympathy of the enquiring mind, which can hardly fail to meet with due appreciation amongst the Members of the Cotteswold Club.

W. V. G.

Notes on British Ferns.

By JAMES BUCKMAN, F.G.S., F.L.S., Professor of Geology and Botany, in the Royal Agricultural College.

A slight acquaintance with plants will shew us that while there are very many that ornament the earth with those showy or curious parts which we term flowers, there are others which do not flower, or at least in the same way, and the differences of these two groups may be summed up in the following manner:

1st, *Flowering Plants*. Bearing leaves whose modifications form other leaves which are called "floral envelopes" (Calyx and Corolla); further change makes (Stamens and Pistils) the latter of which contains the germ and produces seed by its maturation.

2nd, *Non-Flowering Plants*, in which is no Calyx or Corolla, and whose sexual organs, if they possess them, are concealed.

In the first or higher class of plants detached cells are produced by the Stamen, and known as *Pollen*; the contents of the Pollen cell are received into a reservoir of the germ, now full of a saccharine formative fluid, upon which they live and propagate new cells, which become united into different shapes, and covered with varied envelopes, and so compounded they separate from the parent plant, and in this state are called seeds, the plumule of which consists of young leaves. Seeds, therefore, may be viewed as separable buds, protected in various ways, and wrapped up in the most convenient form.

In the Non-flowering plants there are also separable cells developed, but here they are not sown in a sugary pabulum like pollen, but, when separated from the plant, they appear to have the power of reproducing other cells, each of which, in the lower tribes, becomes an independent plant, whilst in the higher the cells do not separate, but make up organs by aggregation, until a distinct organ is set apart for the production of the separable cell, which,

in these, is the seed. Hence the reproduction, as shewn in the two great divisions of plants, may be thus summed up:

In Flowering Plants.

A separable cell is formed. "Pollen," which is sown in the Pistil, and produces the embryo of a plant, "Seed," corresponding with the higher orders of animal life, in which the egg is hatched in the parent.

In Non-Flowering Plants.

A separable cell becomes the future Plant, without mediate gestation—warmth, moisture, and surrounding media—thus analogous to the production of animals from eggs.

Now it is to the non-flowering plants that the Ferns belong, and inasmuch as they have leafy appendages, whilst the Fungi have not; we hence form two groups of non-flowering plants, or,

ACOTYLEDONS.

a. Plants without leaves, sometimes forming a kind of crust or Thallus (*Thallo gens*)—Fungi, Lichens, &c.

b. Plants with leaves, whose parts modify to produce spores, seed, (*Acro gens*)—Mosses and Ferns.

Native Ferns present the following parts:—

A root, more or less fibrous, sometimes springing from an underground stem, *Rhizome*; this is the true stem of the plant, the which, growing upright, constitutes the tree fern of the tropics.

Leaves (*Fronds* of the Botanist), consisting of a leaf-stem (*Stipes*), which sending out fibres right and left, covered by expansions of the bark, constitutes the green leaf-matter. The frond may be entire as in the *Hartstongue*, simply winged as in the common *Polypody* and *Hard Fern*, or doubly winged as in the *Lady Fern*; the first divisions being termed *pinnæ*, the smaller ones *pinnulæ*.

Fronds of Ferns are distinguished from the leaves of flowering plants, 1st, by an involute method of growth, the young leaf being rolled over like a shepherd's crook or pastoral staff.

In the compound fronds æstivation proceeds as follows:—The frond gradually unfolds lengthwise. Then the *pinnæ* unroll. The *pinnulæ* follow, and the more or less divided leaf is exposed to view.

2nd, The ramifications of its woody fibre, forming "*leaf veins*," are always in a *bifurcate* or fork-veined form.

Seeds are the result of the gradual separation of a cell destined for reproduction, and which are thus produced:—1st, The Capsule, which, in some examples, as the *Shield Fern*, consists of a membranous case having a row of cells involuted around it, forming a spring to liberate the *sporules*. Or the *pinnulæ* are metamorphosed into seed cases, as in the *Royal Fern*. Bunches of the former are called *Sori*—the cases of the latter *Theca*.

The number of seeds produced on a single Fern may be estimated by the following calculation, arrived at from an examination of the *Aspidium Filix Mas*, Male or Shield Fern.

A capsule contains 20 cells, sporules. A sori consists of 40 capsules. Each pinnulæ has 6 sori. There are 22 pinnulæ to each pinnæ. There are 40 pinnæ to each frond. There are 8 fronds to each root.

Hence $20 \times 40 \times 6 \times 22 \times 40 \times 8 = 33,792,000$.

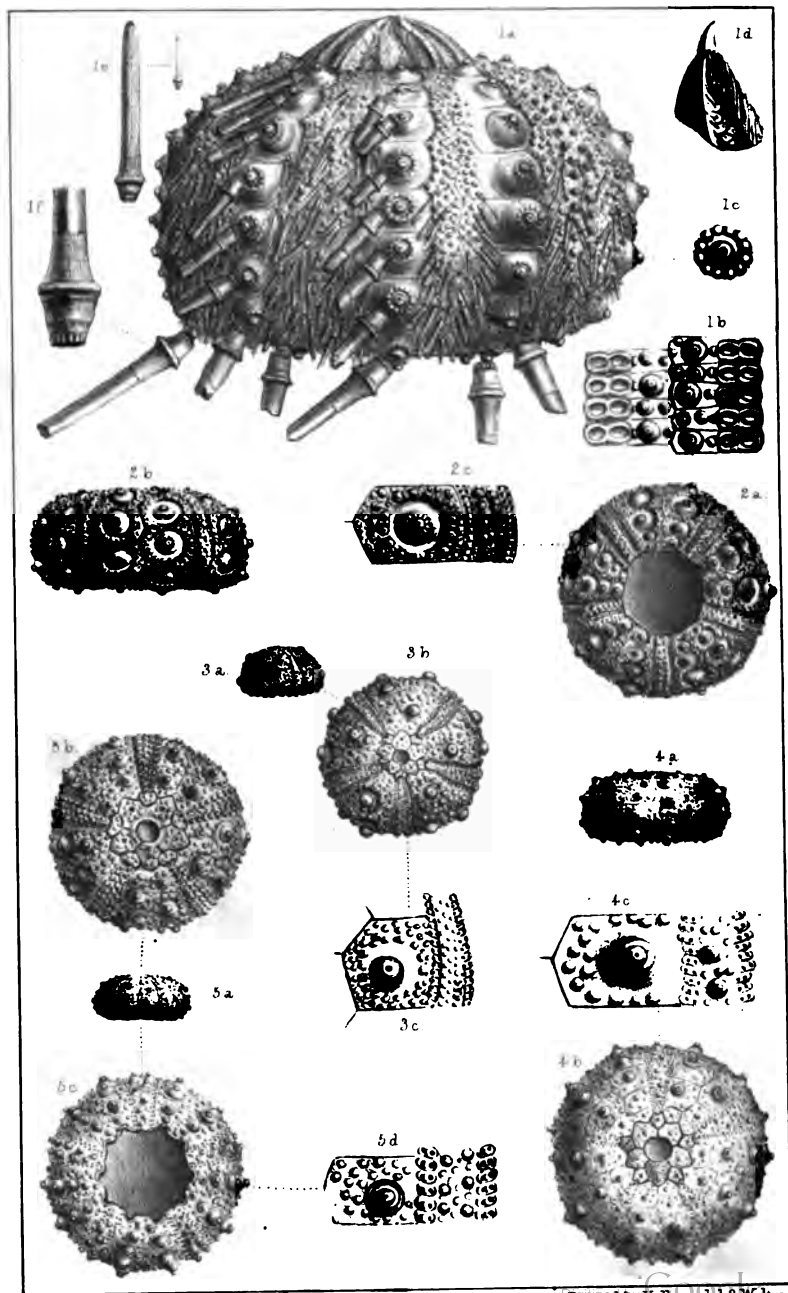
The necessity for the production of so many seeds is explained when we consider that ferns cannot grow everywhere; hence the casualties to which they are liable are amply provided for.

The clusters of capsules, in most instances, begin forming beneath the epidermis, and attach to the nervures on the under side of the frond, the epidermis remaining as a protective covering until the seeds are ripe, when it dries up. The form and disposition of this membrane, which is analogous to the Calyx, differs in different genera and species; it is called an Involucre or *Indusium*.

In as far as British Ferns are concerned, we may divide them into genera, depending upon the *presence or absence*, the *disposition*, and form of the parts heretofore described. The species being dependent, for the most part, upon the form of the divisions of the frond.

The following is a List of the Genera of the British Ferns.

- | | | |
|--|---|----------------------------|
| 1. Sori nude. That is, not covered by an Indusium. | { | 1. <i>Ceterach</i> . |
| | | 2. <i>Polypodium</i> . |
| | | 3. <i>Woodsia</i> . |
| 2. Sori, covered by an Indusium. | { | 4. <i>Aspidium</i> . |
| | | 5. <i>Cystopteris</i> . |
| | | 6. <i>Asplenium</i> . |
| | | 7. <i>Scolopendrium</i> . |
| | | 8. <i>Pteris</i> . |
| | | 9. <i>Cryptogramma</i> . |
| | | 10. <i>Blechnum</i> . |
| | | 11. <i>Adiantum</i> . |
| 3. Thecæ (Seed vessels) Open cases at the edges of the leaves. | { | 12. <i>Trichomenes</i> . |
| | | 13. <i>Hymenophyllum</i> . |
| Thecæ, closed capsules, splitting by a pore. | { | 14. <i>Botrychium</i> . |
| | | 15. <i>Osmunda</i> . |
| | | 16. <i>Ophioglossum</i> . |



Contributions to the Palæontology of Gloucestershire:—A description, with Figures, of some new Species of Echinodermata from the Lias and Oolites. By THOMAS WRIGHT, M.D. &c., Professor of the Natural Sciences in the Cheltenham Grammar School.

READ 4TH MAY 1852.

Cidaris Edwardsii, Wright. Pl. I. fig. 1, a-f.

Test crushed, the form therefore unknown. Ambulacral areas narrow, with two rows of small perforated tubercles, and smaller perforated ones interspersed amongst them; interambulacral areas about four times the width of the ambulacral, having two rows of large tubercles with confluent areolas; the primary spines long, with a compound structure; the secondary spines short with blunt apices, the surfaces of both sculptured with delicate longitudinal lines; mouth armed with powerful jaws, each with three prominent tricarinated ridges. Upper part of the test and ovarial disc unknown.

Description.—It is much to be regretted that no other specimens of this noble Urchin but the one before us has been obtained from the Lias of Gloucestershire, and as the specimen exhibits only the lower half of the test, many points of its anatomy remain unknown; enough of its structure, however, is shown to enable us to point out some important affinities and differences in this rare species.

The narrow ambulacral areas are provided with two rows of small perforated tubercles, amongst which smaller tubercles are irregularly scattered; these tubercles all support short stout spines with a minutely sculptured surface, and which are abundantly preserved *in situ* on the specimen. The wide poriferous avenues are occupied with large oblong pedal pores with very thin partition-walls between them, a circumstance which forms a good diagnostic character between *C. Edwardsii* and *C. Fowleri*, which it very much resembles in many points of structure, the pores in *C. Fowleri* being small and separated by thick partition-walls. The interambulacral areas are four times the width of the ambulacral, and are occupied by two rows of large tubercles set closely together in a vertical direction, so that the areolas above and below are quite confluent throughout.

VOL. II.

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The imperfect condition of the shell prevents us from ascertaining the precise number of these tubercles there were in each row, but judging from the number (eight) contained in an imperfect column, we suppose there could not have been less than from twelve to fourteen; they increase gradually in size from the mouth upwards, and are of a moderate magnitude when compared with the shell they adorn. The areolas are small and not prominent, and the tubercles are deeply perforated. The space between the two rows of tubercles is wide and filled with close-set miliary tubercles, most of which are raised on elevations, and have their summits perforated; these all support small spines, which are well preserved *in situ* in our specimen.

The spines are of two kinds—those articulated with the large tubercles (the primaries), and those articulated with the small tubercles (the secondaries). The primary spines exhibit a peculiar structure: the head is large, increasing gradually in diameter from the articulating cavity to the circular band; the rim of the acetabulum is coarsely and deeply crenulated, and the raised band is prominent, narrow, and finely milled; the neck tapers gradually from the band to the point where it joins the stem, which has the same structure as the head, and its surface is delicately sculptured with fine longitudinal lines; the stem is united to the neck by an oblique harmonia suture. The structure of this part of the spine differs from that of the head and neck; in the spines denuded of their external layer, it has a horny semi-transparent appearance; in those in which this layer is present the surface is sculptured with longitudinal lines of microscopic delicacy, and there are numerous small processes, having their points directed forwards, arranged with some regularity in rows. The stem is circular or slightly compressed; but as none of the spines are complete, a part having been broken off, we are unable to ascertain their length. The secondary spines are very uniform in size and structure, and are abundantly preserved *in situ*; they measure from $\frac{6}{80}$ ths to $\frac{7}{80}$ ths of an inch in length and are round, and have their surface ornamented with fine longitudinal lines. The mouth is armed with a powerful dental apparatus: three of the jaws are very prominent; the external surface of each is strengthened by three prominent ridges; the teeth are large, but are fractured. As the under surface of the test only is shown, we are unable to describe the ovarian disc and the dorsal surface thereof.

Affinities and differences.—This Urchin belongs to the same group as *C. Fowleri* and *C. maxima*, Goldf. It resembles the former in the form and structure of both areas, and in the gradual development of the primary tubercles from the mouth upwards. It is distinguished from that species, however, by the

greater size and uniform perforation of the miliary tubercles, but above all by the form and structure of the primary spines. Having ascertained that our conjecture* relative to the spines of *C. Fowleri* is correct, from having seen a specimen recently found with some spines attached to it, we can speak positively upon this point.

Locality and stratigraphical range.—Found by Mr. G. E. Gavey, C.E., in the upper shale beds of the Lower Lias at Mickleton Tunnel near Chipping Campden. It was associated with *Pentacrinus Goldfussii*, Wright, *Ophioderma Gaveyi*, Wright, *Uraster Gaveyi*, Forbes, and *Ammonites planicosta*, Sow.

History.—Isolated plates of this species have been found in beds of the same geological horizon in other localities of the county of Gloucester, but the specimen before us is the only one from which the anatomy of the Urchin could be made out. We dedicate this species to Prof. Milne-Edwards, of the Museum of Natural History at the Jardin des Plantes, Paris, as a tribute of gratitude for the pleasure and profit derived from the study of his admirable monograph on British Fossil Corals.

Cidaris Bouchardii, Wright. Pl. I. fig. 2, a-c.

Test circular, depressed; ambulacral areas narrow and flexuous; interambulacral areas with two rows of primary tubercles, 5-6 in each row; the areolas of the small mammillary eminences deeply excavated, and surrounded by an elevated ridge, on which a distinct circle of granules for each areolar space is disposed.

Dimensions of the largest specimen. Height $\frac{1}{2}\frac{3}{4}$ ths of an inch, transverse diameter 1 inch and $\frac{1}{10}$ ths.

Dimensions of a moderate-sized specimen. Height $\frac{1}{2}\frac{1}{8}$ ths of an inch, transverse diameter 1 inch and $\frac{2}{10}$ ths.

Description.—It was for some time doubted whether the young forms of this Urchin were not the *C. elegans*, Goldf., but a comparison of several individuals of our fossil with a typical specimen of Goldfuss's species, kindly sent us by our friend Dr. Roemer of Bonn, which he had identified with the original *C. elegans* in the Bonn Museum now under his care, has convinced us of their distinctness. The test of our Urchin is circular and much depressed from the great flattening of both poles; the ambulacral areas are narrow and slightly flexuous, and have two rows of small marginal granules set nearly opposite to each other throughout the areas. The poriferous avenues are much depressed, and the pairs of pedal pores are

* Annals of Nat. Hist. Oct. 1851.

disposed in a single file. The interambulacral areas are about five times the width of the ambulacral, and have two rows of primary tubercles of moderate size, with from five to six in each row. The mammillary eminences on which the tubercles are supported are surrounded by areolas deeply excavated out of the substance of the test plates; the margin bounding the areolas is raised into a ridge on which a distinct row of close-set granules is disposed, so that each tubercle is thereby separated from its fellow; the elevation of the marginal ridges produces a zigzag depression down the centre of the areas, which is covered with a small close-set granulation. The mouth-opening is small and circular, and lies in a slight depression; the apical disc is absent in all the specimens that have yet been found. The crenulations on the mammæ are small, but distinct, and the tubercles are of moderate size and not deeply perforated.

Affinities and differences.—This Urchin has many affinities with *C. coronata*, Goldf., and *C. propinqua*, Münst., and has been catalogued as the former by some authors; it is therefore important that we should point out the diagnostic characters by which it is distinguished from them. In both these corallian forms the ambulacral areas have four rows of granules, whilst in *C. Bouchardii* there are only two rows. From *C. propinqua* and *C. coronata* it is further distinguished by having more rows of primary tubercles in the interambulacral areas, in having the areolas smaller and more deeply sunk, the tubercles proportionately smaller, and the marginal circle of granules smaller and set closer together. With *C. marginata*, Goldf., it has some affinity in the excavated style of its areolar spaces, but it is distinguished from this beautiful form in having the tubercles smaller and more numerous. In *C. marginata* the ambulacral areas moreover are broader and more prominent, and they support four rows of small granules, whilst in *C. Bouchardii* there are only two. With *C. elegans*, Goldf., it has no resemblance whatever; it belongs therefore to a different group of Cidarites than these foreign corallian forms. From *C. Fowleri*, nobis, it is distinguished by having narrower and more deeply concealed poriferous avenues, fewer primary tubercles in the interambulacral areas, and deeper excavated areolar spaces with a more elevated marginal rim around them: these characters serve to distinguish *C. Fowleri* from *C. Bouchardii* at a glance, and the same diagnostic traits separate it from *C. Edwardsii*, nobis.

Locality and stratigraphical range.—We have found this species in the Pea-grit of the Inferior Oolite of Crickley, Leckhampton, and Birdlip Hills, Gloucestershire, but have never met with any traces of it in the Upper Ragstone beds so rich in Urchin forms. Some separate plates collected from the Bradford

clay near the Tetbury Road Station, Great Western Railway, closely resemble this form ; but as no entire specimen, that we are aware of, has been found, it is impossible to state whether it has a wider range in the higher beds of the lower division of the Oolites or not.

We dedicate this species to our friend M. Bouchard Chantereaux of Boulogne, to whom we are indebted for some beautiful and rare specimens of Echinoderms and other fossils from the rocks of the Boulonnais, most kindly contributed by him to aid us in the composition of these memoirs.

Hemicidaris minor, Agassiz. Pl. I. fig. 3, *a-c*.

SYN. *Hemicidaris minor*, Agassiz, Catalogus Systematicus, p. 9 ; Agassiz and Desor's Catalogue raisonné des Echinides, Annales des Sci. Nat. tom. vi. p. 339.

Acrosalenia rarispina, M'Coy, Ann. of Nat. Hist. 2nd Series, vol. ii. p. 411.

Test hemispherical above, flat at the base ; ambulacral areas slightly flexuous, not prominent, with six large tubercles at their base, and four rows of small unequal-sized granules in the middle, diminishing to two rows in the upper part of the areas ; interambulacral areas three times the width of the ambulacral, with three primary tubercles on the upper surface and three smaller ones at the base ; the wide intertubercular spaces are covered with small distinct nearly equal-sized granules, which form complete circles around the margins of the areolas of the primary tubercles ; the apical disc is of moderate size, and its ovarian plates are covered with a delicate granulation ; base flat, mouth-opening large and decagonal ; pores arranged in the avenues in a single file throughout.

Height $\frac{6}{10}$ ths of an inch, transverse diameter $\frac{9}{10}$ ths of an inch.

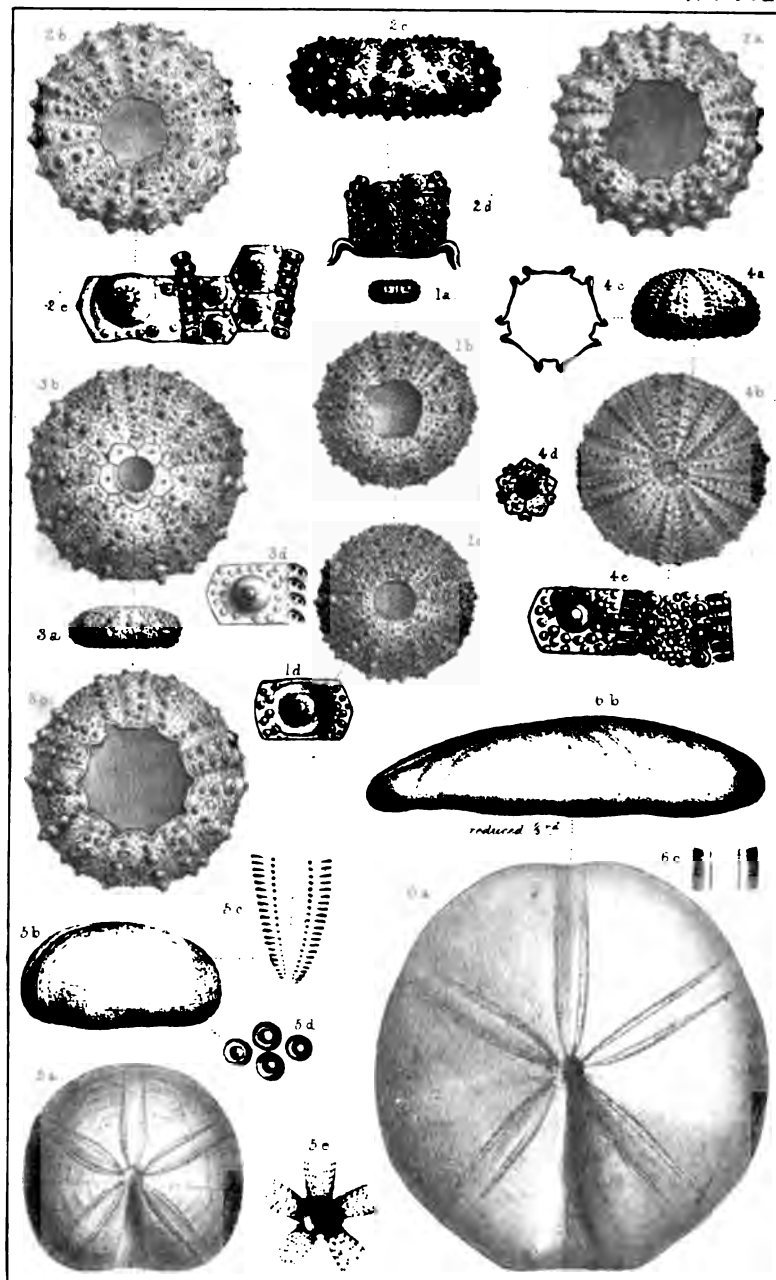
Description.—This beautiful little Urchin was first discovered in the étage Bathonien of Langrune, Calvados, the true equivalent of the Great Oolite of English geologists ; it was entered in M. Agassiz's 'Catalogus Systematicus*', as *Hemicidaris minor*, from specimens sent to him by M. Michelin ; it afterwards found a place in the 'Catalogue raisonné des Echinides' of Agassiz and Desor, accompanied with this remark : "Se distingue entre tous les *Hemicidaris* par les tubercules très espacés, dont il n'y a que deux ou trois dans une rangée.—Terrain Jurassique de France.—Michelin." Professor M'Coy, in his paper "On some new Mesozoic Radiata†," afterwards described this Urchin under the

* Catalogus Systematicus Ectyporum Echinoderm. Foss. Mus. Neocomensis, 1840.

† Annals of Natural History, 2nd Series, vol. ii. p. 411.

name *Acrosalenia rarispina*, giving the Great Oolite of Minchinhampton for its locality. As that gentleman has kindly favoured us with pen-and-ink sketches of the species described as new in that paper, we have no difficulty in deciding on the identity of his specimen. Moreover we have ascertained the collection from whence it originally came. The error committed by this learned author in the genus must have arisen from the disc in his specimen having been covered with "adhering siliceous matrix," and from his having overlooked the very remarkable character pointed out by Agassiz, "les tubercules très espacés." We have been fortunate to receive a typical specimen of the original species from the Great Oolite of Langrune, through the kindness of our friend Professor Deslongchamps; we have compared the French Urchin with specimens obtained from the same locality as that from whence Prof. M'Coy's was collected, and there is not a shadow of a doubt about their perfect identity. We have figured in detail this beautiful and singular form, to prevent the possibility of mistakes occurring about it in future.

This pretty little *Hemicidaris* is very distinct from all others of the group to which it belongs: the test is nearly hemispherical, and the few primary tubercles stand prominently at great distances apart from the surface of the test. The narrow ambulacral areas are slightly flexuous above, and have from four to six large perforated tubercles at their base only, the sides and upper part of the areas having first four, and then two rows of small imperforate granules upon their surface about equal in size to the granulation which covers other parts of the test. The poriferous avenues are depressed, and the pedal pores are disposed in pairs throughout. The interambulacral areas depart considerably from the typical structure of this portion of the test in other Echinidæ; they are three times the width of the ambulacra, and have at their base three large primary tubercles, two on one side and one on the other, with a smaller tubercle above the single large one; on the sides and upper part of the areas there are only three primary tubercles, two on one side and one on the other, making only three pairs of primary tubercles in the interambulacral areas, those of the base being closely set together, and those on the sides at great distances apart; the tubercles are large and hemispherical and only slightly perforated; the mammillary eminences which support them are small and ring-like with faintly marked crenulations, and the areolas are rather wide and only slightly grooved, so that the tubercles project prominently and abruptly from the surface of the test. The margin of the areolas is encircled by a row of granules rather larger than those which cover the rest of the intertubercular surface of the plates; here the granules are close-set and disposed without much regularity.



W.H. Bailey

Printed by Hulimandl & Walter.

- 1 a, d. *Achnanthes crumifera*
 2 a, e. *Eladema Davidsoni*
 3 a, d. *Moorei*
 4 a, e. *Polysiphonia Desionchampi*
 5 a, e. *Nitidulites Woodwardi*
 6 a, c. *Michelinia*

Wright

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The apical disc is of moderate size and slightly prominent; the five ovarian plates are large and of a heptagonal form, the ocular plates are small and heart-shaped, and the surface of both is covered with a close-set delicate granulation; the anal opening is nearly central and circular; the base is flat; the mouth-opening is large and widely decagonal from the great span of the ambulacral arches, and the comparative smallness of those of the interambulacra. The spines are as yet unknown.

Affinities and differences.—This remarkable little Urchin is so entirely different from its congeners, that it is impossible to mistake it for any other of the group to which it belongs. The presence of tubercles at the base of the ambulacral areas only, and of granules on the sides of these spaces, associate it with *H. diademata*, but the small number of the primary tubercles on the interambulacra, added to the great distance at which they are placed apart, serve to distinguish it from the young of that species; in fact, these characters alone are perfectly diagnostic of *H. minor* among all other forms of *Hemicidaris*.

Locality and stratigraphical range.—It was first found in the "Grand Oolite" of Langrune, Calvados, from whence the beautiful specimen before us was obtained, and kindly sent by Professor Deslongchamps of Caen. We take the present opportunity of recording our grateful acknowledgements to that eminent naturalist for his kindness and courtesy, not only in contributing specimens to our cabinet for comparison and reference, but likewise for communicating many rare species of oolitic Echinidæ which served as the types of several of M. Agassiz's species, and which specimens have been of much service in clearing up doubts as to the identity of some other English forms. *H. minor* was collected in this country by W. Walton, Esq., from the Great Oolite of Hampton near Bath.

History.—First named by M. Agassiz from specimens in M. Michelin's cabinet; afterwards described as *Acrosalenia rarispinia* by Prof. M'Coy from specimens in the Cambridge Museum, which came from Mr. Walton's series collected near Bath; it has never yet been found either by Mr. Lycett or ourselves in the Great Oolite of Minchinhampton.

Acrosalenia crinifera, Wright. Pl. II. fig. 1, a-d.

SYN. *Echinus minutus*, Buckman, Geology of Cheltenham, 2nd ed. p. 95.

Cidarites criniferus, Quenstedt, Handbuch der Petrefactenkunde, tab. 49. fig. 32. p. 574.

Test circular, depressed; ambulacral areas narrow, with two rows of microscopic tubercles placed at some distance apart on each

side of the areas, those of the right side alternating with those of the left ; interambulacral areas with two rows of primary tubercles, 9-10 in each row, so disposed that the test appears to possess only ten rows of primary tubercles nearly equidistant from each other ; spines long, numerous and hair-like.

Height $\frac{5}{8}$ ths of an inch, transverse diameter $\frac{6}{8}$ ths of an inch.

Description.—This singular little Urchin has been long known to collectors, and has been often a puzzle to them, for although a few specimens have been collected in a tolerable state of preservation, still for the most part the test is much injured by pyrites ; under the most favourable circumstances, it requires a good lens and much patient study to make out the details of its structure. It was first found in the black shales of the lower Lias near this town, and recently, with its hair-like spines attached to the test, from the same bed near Gloucester, when excavating the new docks of that city ; it was there associated with *Ammonites oxymotus*, Quenst. It is difficult to say whether this tiny Urchin is a *Hemicidaris* or an *Acrosalenia*, and the absence of the apical disc leaves the question unsolved ; we incline to the opinion that it is an *Acrosalenia* from the structure of the ambulacral areas, the shape, length and development of the spines when compared with the diameter of the test, the spines being more than four times the diameter of the latter ; be this however as it may, it is neither an *Echinus* nor a *Cidaris*, as previous authors have supposed. The ambulacral areas are narrow, with two rows of small marginal tubercles not much larger than the common granulation of the test ; these tubercles are placed in each row at some distance apart, and the tubercles of the one side alternate with those of the opposite side ; between these rows of tubercles the surface of the plates is adorned with a delicate granulation, which is arranged into a zigzag line ; the tubercles are very uniform in size and distribution throughout the areas, and do not increase at the base thereof, as is the case in the genus *Hemicidaris*. The interambulacral areas are wide, and have two rows of primary tubercles, from 9-10 in each row ; their mammillary eminences have well-defined areolas, the summits of the mammæ are deeply crenulated, and the tubercles are small and widely perforated ; the areolas are confluent above and below ; between the two rows of tubercles an elevated band extends from the mouth to the apical disc, composed of from 4-6 rows of unequal-sized granules. When viewed at the equator with the naked eye, this Urchin appears to possess only ten rows of tubercles placed nearly equidistant from each other ; but when examined with an inch object-glass under the microscope its true structure is disclosed,—the narrowness of the ambulacral

areas, the closeness and smallness of their rows of tubercles, the granular band down the centre of the interambulacra, and the unequal size of its component tubercles, alike contribute to make the deception almost complete.

The most remarkable parts of the structure of this tiny fossil are the spines, which in some crushed specimens are preserved *in situ*; they are long, delicate and hair-like, and have large articular heads; these spines look like so many bristles laid down in all directions upon some slabs of the Lias shales; in a crushed test of four-tenths of an inch in diameter the spines measured an inch and a half in length.

Affinities and differences.—The only *Cidarites* for which *A. crinifera* is likely to be mistaken are *Diadema Moorei* and *Pedina Etheridgii*; from the former it is easily distinguished by the narrowness of the ambulacral areas and the smallness of the tubercles thereof; from the latter it differs in the comparative smallness of its ambulacral areas, and above all in having the mammillary eminences of its tubercles deeply crenulated, a character which is absent in all the *Pedinas* we know; at present we know of no other *Urchin* in the Lias for which it can be mistaken.

Locality and stratigraphical range.—*A. crinifera* has been found only in the lower shales of the lower Lias near Lansdowne, Cheltenham, and in the same stratum near Gloucester; it is associated with *Turritiles Valdani*, D'Orbig., and *Ammonites oxynotus*, Quenstedt. It has been collected by Prof. Quenstedt in the lowest schist of the "Posidonienschiefer von Pliensbach bei Boll" in Würtemberg. We have before us now two slabs of this curious bed; one surface of the slab is covered over with the long hair-like spines strewn about in all directions, with here and there the crushed test of one of these *Urchins* with its spines attached and *in situ*.

History.—Described by Mr. Buckman under the name *Echinus minutus*, but previously noticed by M. Quenstedt in his work on the Flötzgebirge of Würtemberg; it has been recently figured by him in his 'Handbuch der Petrefactenkunde,' under the name *Cidarites criniferus*.

Diadema Davidsoni, Wright. Pl. II. fig. 2, a-e.

Test depressed, circular; tubercles elevated upon prominent mammillary eminences; pores in a single file throughout; a few small secondary tubercles in the interambulacra; the primary ambulacral tubercles nearly as large as those of the interambulacra.

Height $\frac{9}{10}$ ths of an inch, transverse diameter 1 inch and $\frac{6}{10}$ ths.

Description.—This beautiful *Urchin* has a regular circular

test, not at all inclined to the pentagonal form of many of its oolitic congeners. The ambulacral areas are three-fourths the width of the interambulacral areas, and are nearly of a uniform width throughout, tapering slightly and gracefully inwards towards their superior third; the contraction assumes the form of a gentle curve slightly inclined towards the centre. The double row of tubercles gradually increases in size from the mouth to the equator, where three pairs are about the same size; from this point upwards they gradually decrease, and terminate in two pairs of minute rudimentary tubercles at the disc. A single row of granules, arranged in a zigzag form, separates the primary tubercles from each other, a larger granule marking each of the angles. There is no granulation or other sculpture between the mammillary eminences of the tubercles and the poriferous avenues. There are from twelve to thirteen pairs of tubercles in each area. The interambulacral areas are nearly $\frac{4}{10}$ ths of an inch in width, and $\frac{1}{4}$ th wider than the ambulacral areas; they retain their width uniformly throughout, and are occupied by two rows of primary tubercles, nine to ten in a row, the mammillary eminences of which are large and prominent, and separated from each other by two rows of small granules which extend only a short distance beyond the equator; the remaining space between their termination and the disc being destitute of sculpture, where likewise the areas are slightly depressed; and a single row of granules rises on the external side of the tubercles, with here and there a secondary tubercle towards the basal portion of the test.

The poriferous avenues are very narrow: the pedal pores are arranged in a single file, only three or four additional pairs being introduced in the increased spaces around the circumference of the mouth. The tubercles of both areas are of moderate size, but exceedingly prominent, in consequence of being elevated upon large mammillary eminences, the apices of which are deeply crenulated. The tubercles of the ambulacral areas at the equator are not much less than those of the interambulacral areas, but upon the upper surface of the test they become much smaller and more numerous.

The mouth is decagonal and of moderate size: the arches over the bases of the ambulacral areas are about one-third greater in span than those across the interambulacra. The disc is absent in all the specimens, four in number, that we have seen.

Affinities and differences.—This species resembles *Cidarites* (*Diadema*) *mamillanus*, Roemer, in the prominence of the tubercles and depression of the test; but Roemer's figure* is so indi-

* Die Versteinerungen des Norddeutschen Oolithen Gebirges, pl. 2. fig. 1.

stinct and devoid of details, that it is impossible to institute a strict comparison between our Urchin and the one figured by him. The difference between *D. Davidsoni* and *D. subangulare* is so marked that it is impossible to mistake them—the pentagonal outline, large tubercles, wide granulated space between the primary tubercles of both areas, with the pores arranged in double files on the upper surface of the test, form a group of characters which distinguish *D. subangulare* from our Urchin. From *D. pseudodiadema* it is distinguished by the tubercles in *D. Davidsoni* of the ambulacral equalling in size those of the interambulacral areas, whilst in that species they are unequal. The rudimentary condition of the secondary tubercles in our species forms a striking contrast to the size they attain in *D. pseudodiadema*. The naked condition of the central parts of the interambulacral areas connects it with *D. subnudum*, Ag., of the Chalk, and the neatness of its outline allies it with other cretaceous forms.

Locality and stratigraphical range.—We have collected this species in the clays of the Coral rag near Calne, Wilts; it is a very rare Urchin, as we only know four specimens of it.

We dedicate this species to our friend Thomas Davidson, Esq., whose learned monographs on the Brachiopoda have earned him the gratitude of all palæontologists. We take this opportunity likewise of recording our deep obligations to Mr. Davidson for many friendly acts of assistance given during the preparation of these memoirs, by which we have been enabled to compare a considerable number of foreign Echinidæ with those of our own island, and thereby have been enabled to obtain a better knowledge of the affinities existing among the Echinoderms of the European Oolitic fauna.

Diadema Moorei, Wright. Pl. II. fig. 3, a-d.

Test circular, depressed; ambulacral tubercles smaller than those of the interambulacral areas; plates of the test covered with a small wide-set prominent granulation; mouth large and decagonal; anal opening large; apical disc of moderate size.

Height $\frac{5}{8}$ ths of an inch, transverse diameter $\frac{1}{2}$ ths of an inch.

Description.—There is much difficulty in distinguishing some of the smaller Diademas from each other, inasmuch as the young condition of many of the larger species so closely resembles the adult state of others, that it is only after one obtains a number of individuals of different species in their various phases of growth, that the naturalist feels himself upon sure ground when he endeavours to distinguish the affinities and differences that exist among them.

After a diligent search for Urchins in the Lias of Gloucestershire, we have succeeded in collecting only a very few examples of this group from these rocks. In addition to those found here, our friend Mr. Moore of Ilminster kindly presented us with a few specimens which he collected from the Upper Lias near Ilminster, and from these collective materials the species under consideration was discovered. *Diadema Moorei* has a circular outline slightly inclining to a pentagonal contour; it is much depressed at the upper surface and is flattened at the base. The ambulacral areas are very narrow, being less than one-third the width of the interambulacral; their margins are occupied by two rows of tubercles about eight in each row, which, at the base and up to the equator, are nearly as large as those of the interambulacra; but from that region to the apex of the area they rapidly diminish in size, and are here very disproportionate in magnitude to them; a zigzag line of single granulation separates the two rows of tubercles from each other. The interambulacral areas are wide and well developed, and have two rows of tubercles, from 8-9 in each row, which occupy the centre of the plates; the areolas of the tubercles on the upper surface are surrounded with a circle of granules which separates them from each other, but those of the base are confluent above and below. The intertubercular surface at the base of the test has a number of granules scattered over it, whilst on the upper surface, the plates are destitute of any other ornament beyond the faint circles that surround the tubercles. The pedal pores are arranged in pairs in a single file; the avenues are, however, rather flexuous below; the basal tubercles of both areas are nearly alike in size, but on the dorsal surface those of the ambulacra dwindle into large granules, whilst those of the interambulacra maintain their size up to the last pair, which are small near the margin of the disc. The mouth-opening is large, and its margin is divided into ten nearly equal-sized lobes. The apical disc is partly preserved in the specimen here figured; it consists of five large ovarian plates of a heptagonal form; two of the sides unite with the interambulacral plates, two with the ocular, two with the adjoining ovarials, and the single surface contributes to form the boundary of the anal opening, which is of moderate size; the five ocular plates are small and heart-shaped, their apex is directed towards the anal opening, and their base to the area; the madreporiform tubercle is slightly elevated on the single ovarian plate, and the surface of the discal plates is almost destitute of sculpture or granulation.

Affinities and differences.—*D. Moorei* resembles *D. depressum*, Ag., in the depression of its upper surface and the flatness of its base, likewise in having the tubercles of both areas of nearly a

uniform size around the base ; but it is readily distinguished from *D. depressum* by the number and greater development of the tubercles of the ambulacra, which maintain their size throughout ; whilst in *D. Moorei* the ambulacral tubercles are fewer in number and rudimentary in size in all the upper part of the areas. The contour of the test moreover does not assume the pentagonal outline of *D. depressum*, nor has the upper surface of the interambulacral areas the median depression seen on the test of the latter. The mouth-opening is larger, and the decagonal lobes are more equal in size in *D. Moorei* than in *D. depressum*.

Locality and stratigraphical range.—We have collected *D. Moorei* in the Upper Lias of Gloucestershire. Mr. Moore found it in the same stratum near Ilminster with *Ammonites communis* and *A. serpentinus*. Professor Deslongchamps has communicated a specimen of this Urchin which he found in the Lias supérieure of May, Calvados, associated with *Leptæna Davidsoni* and *Thecidea Bouchardii* and several other species.

We dedicate this species to Mr. Moore, of Ilminster, whose assiduous researches have brought to light so many interesting forms from the Upper Liassic beds of Somersetshire.

Genus PEDINA, Agassiz.

As this genus was incorrectly defined in our memoir on the Cidaridæ, it having been there stated that the mammillary eminences were “crenulated like those of *Diadema*,” we take this opportunity of correcting the error, and giving a definition more in accordance with our present knowledge.

Test thin, circular, more or less depressed ; primary tubercles small and perforated ; mammillary eminences with smooth ring-like summits without crenulations ; pores in general disposed in triple oblique pairs ; mouth small and slightly decagonal, margin not much notched ; ovarial disc small and not prominent ; ambulacral areas with one, two, or more rows of small tubercles ; interambulacral areas sometimes with two rows only, sometimes with two rows and additional secondary rows of tubercles more or less complete.

This genus is extinct, and is found in the oolitic cretaceous rocks.

Pedina Bakeri, Wright. Pl. I. fig. 4, a-c.

Test circular, depressed ; ambulacral areas narrow, with one row of small tubercles disposed in a slightly zigzag line down the centre of the areas ; interambulacral areas broad, with two rows of primary tubercles raised on prominent mammillary emi-

nences in the centre of the plates; the margins of the areolas surrounded with circles of small granules; no secondary tubercles.

Height $\frac{7}{10}$ ths of an inch, transverse diameter $\frac{1}{2}$ ths of an inch.

Description.—This *Pedina* presents a different form from its other congeners: the test is circular and depressed; the ambulacral areas are narrow, about one-third the width of the interambulacra; the usual double row of tubercles in this region is reduced to one row, the tubercles of which are disposed alternately on the right and left sides of the areas, thereby forming a single zigzag line down the centre thereof; the tubercles at the equator and on the upper surface are small, but there are two or three of a larger size at the base of the areas; a few granules form imperfect crescents round their narrow areolas. The interambulacral areas are nearly three times the width of the ambulacra; they are adorned with five pairs of primary tubercles of nearly a uniform size throughout, which are raised on prominent mammillary eminences, the summits of which are smooth, ring-like and without crenulations; circles of small granules bound the areolar spaces; there are no secondary tubercles, nor any sculpture upon the intertubercular surface of the plates, so that down the centre of the areas there is a smooth valley between the primary tubercles. The apical disc is well preserved in our specimen; the ovarian plates are of an irregular octagonal form and of moderate size, they are covered with a few granules scattered irregularly over their surface; the ocular plates are of a rhomboidal form and have large eye-holes. The base of the specimen is covered up with hard rock, so that it is impossible to expose the mouth-opening without endangering the specimen.

Affinities and differences.—The *Pedina* have been so imperfectly described by M. Agassiz in his 'Descriptions des Echinodermes fossiles de la Suisse,' that there is much difficulty in making out the species figured and described in that monograph. When it is recollected how limited were the materials at Agassiz's command when he published that valuable contribution to Palæontology, and how delicate the test of this genus is, we can readily understand how so many different forms of the same Urchin came to be described and named as distinct species. After a careful examination of many specimens, we confess that *Pedina aspera*, *rotata*, *ornata* and *sublævis*, Agass., appear to us to be so many different forms of one and the same species. We have before us likewise the original type specimen of *P. granulosa*, Ag., which has been kindly communicated by Professor Deslongchamps. An examination of that Urchin has convinced us

that it is only a larger individual of *P. aspera*, as we find it in the Inferior Oolite, and is identical with the fossil which we have described as *P. rotata*. On a further examination of this specimen, M. Agassiz, it would appear, had arrived at a similar conclusion, for on the ticket which accompanies it is the following remark in his handwriting :—" *Pedina granulosa*, Ag. C'est sous ce nom que cette espèce est citée dans mon catalogue ; cependant il se pourrait qu'elle ne fut qu'une variété un peu enflée de mon *P. aspera*." This species was collected by Prof. Deslongchamps from the Great Oolite of Ranville. We have likewise before us a portion of *Pedina* collected from the Oxford clay of the Boulonnais by M. Bouchard-Chantereaux, and marked by that eminent palæontologist, who kindly sent us the specimen, "très rare. J'en ai encore trouvé que trois morceaux de cette espèce." It so nearly resembles the Ranville Urchin that we have no doubt of their identity. By the extreme kindness of M. Michelin and M. de Lorière, we have before us specimens of *P. Gervillii*, Ag., from the Kellovien étage of Chauffour, department of the Sarthe, which are identical with *Pedina aspera* or *rotata*, collected by us from the upper beds of the Inferior Oolite of Gloucestershire. In fact the French and English specimens are so entirely alike, that we should mistake the one for the other had we not previously marked them. It would appear from these remarks, that whether we retain the specific name *rotata* or *aspera* for this widely distributed Urchin, we must at least cancel the other names which have been given to various forms of the same, as we have now before us well-preserved specimens from the Inferior Oolite, Gloucestershire, the Great Oolite, Ranville, Calvados, the Oxford clay near Boulogne, Pas de Calais, the Kellovien of Chauffour, Sarthe.

[Since these sheets were sent to press, the Rev. A. W. Griesbach has communicated a *Pedina*, collected by him in the Cornbrash at Rushden, Northamptonshire ; as this fossil is in a good state of preservation, we have been able to make a careful comparison of it with a fine *P. aspera* now before us, and there can be no doubt of their identity. The discovery of this Urchin in the Cornbrash is another link in the chain of evidence showing the wide stratigraphical range of this form in the Oolitic seas.]

P. Bakeri differs so entirely from the forms named in the preceding remarks, that it is impossible to mistake it for either of them ; its diagnostic characters consist of the size and small number of the primary tubercles, the absence of secondary tubercles, the scanty granulation on the interambulacral areas, the narrowness of the ambulacra, and the single row of tubercles thereon. We have only met with the small but tolerably perfect specimen of this species figured (Pl. I. fig. 4, a-c).

Locality and stratigraphical range.—We collected this rare form of *Pedina* from the Pea-grit of Crickley Hill, and have seen fragments of its test in the same bed at Leckhampton, but never in any other locality.

We dedicate this species to our friend T. Barwick L. Baker, Esq., of Hardwicke Court, the President of the Cotteswold Naturalists' Club, for the warm interest he takes in the progress of the Palæontology of Gloucestershire.

Pedina Etheridgii, Wright. Pl. I. fig. 5, a-d.

Test circular, depressed; ambulacral areas with from six to eight small perforate tubercles at their base, and a double row of small granules on their upper surface; the interambulacral areas with primary tubercles only, the areolas of which are surrounded with regular circles of granules; pedal pores not numerous, arranged in nearly a single file with a slight elevation between the two pores of each pair; apical disc large; ovarian plates leaf-like; mouth-opening small.

Height $\frac{5}{8}$ ths of an inch, transverse diameter $\frac{10}{8}$ ths of an inch.

Description.—This pretty little Urchin has a circular outline in the young state, which in larger specimens inclines towards a pentagonal form; the base is flattened, and the upper surface of the test is much depressed. The ambulacral areas are narrow, and have from six to eight small perforated tubercles at their base, and a double row of from twelve to fourteen minute imperforate granules in each row on their upper surface, which in figure and size resemble those covering the other parts of the test; between the pedal pores of each pair is a small elevation; these collectively form a prominent moniliform line which extends from the margin of the disc to the mouth-opening; the pores are disposed in nearly a single file, and do not form the triple oblique pairs which we observe in the larger *Pedinae*. The interambulacral areas are about twice the width of the ambulacra; the rows of primary tubercles occupying the centre of the plates have seven tubercles in each row, they are small in size and are rendered prominent from being raised upon uncrenulated mammillary eminences, the bases of which are sharply defined and surrounded by complete circles of moderately sized and regularly arranged granules; the regular disposition of these granulations gives an air of decoration to this little species not observed among other congeneric forms; the entire absence of secondary tubercles from the areas renders the decoration more complete. The apical disc is large; the ovarian plates are widely rhomboidal, the oculars are small and heart-shaped, and the sur-

face of both is covered with minute granules nearly as large as those which adorn the other parts of the test. The madreporiform tubercle makes a distinct elevation on the surface of the single plate, and the anal aperture is transversely oblong; the base is flat, the mouth-opening is small, and its margin is divided into ten nearly equal-sized lobes; the spines are unknown.

Affinities and differences.—In its general outline and depressed upper surface, with the pedal pores in nearly a single file, this little Urchin resembles a *Diadema*; from that group however it is distinguished by the rudimentary condition of the ambulacral tubercles, and the absence of crenulations from the summits of the mammillary eminences. It is distinguished from *P. Bakeri* by having small primary tubercles set more closely together, and in having a greater number in each row. From *P. aspera* it is known by having the upper surface more depressed, the pedal pores separated by a moniliform line of granules, and in the absence of secondary tubercles. It has a strong resemblance at a first glance to *Diadema Moorei*, but an examination with the lens at once discloses the points of difference, which are these:—the ambulacral areas in *Pedina Etheridgii* have imperforate granules on their upper parts, whilst in *Diadema Moorei* there are perforated tubercles; the moniliform line between the pedal pores in *P. Etheridgii* is absent in *D. Moorei*; the mouth-opening is likewise much smaller in *P. Etheridgii* than it is in *D. Moorei*.

Locality and stratigraphical range.—*P. Etheridgii* has been collected from the marlstone of Bredon Hill, Gloucestershire. Mr. Moore found it in the Upper Lias of Ilminster, and we have collected several specimens from the Pea-grit (Inferior Oolite) of Crickley and Leckhampton Hills, but have never seen a trace of this species in any of the upper beds; it seems therefore to have a limited vertical range between the marlstone and the basement-beds of the Inferior Oolite, and is one of the few species which lived in the Liassic and Oolitic seas.

We dedicate this species to our friend Mr. Etheridge, of the Bristol Museum, who has kindly assisted us in comparing our specimens with the fine series of Echinoderms under his care, and has likewise otherwise aided us in the most friendly manner in working out the subjects of these memoirs.

Genus POLYCYPHUS, Agassiz.

Small Urchins having a subglobular form; the upper surface of the test is covered with numerous small imperforate tubercles of a very uniform size; the base and basal angle are furnished with several tubercles of a size disproportionately large when compared with those of the upper surface; the pedal pores are dis-

posed in a triple oblique series of pairs ; the mouth is large and pentagonal ; the anal plates form a narrow prominent ring at the vertex, and the interambulacral areas are in general divided by a median depression.

Polycyphus nodulosus, Münster.

SYN. *Echinus nodulosus*, Goldfuss, Petrefact. Ger. tab. 40. fig. 16 ; Agassiz, Cat. Syst. p. 12.
Arbacia nodulosa, Agass. Prodröm.
Polycyphus nodulosus, Agass. & Desor's Cat. raisonné, Ann. Scien. Nat. tome vi. p. 361.

Test hemispherical ; ambulacral areas a little more prominent than the interambulacral areas ; ambulacra with from four to five rows, and interambulacra with from twelve to fourteen rows of small tubercles disposed in nearly parallel lines ; bases of the ambulacra with twelve, those of the interambulacra with sixteen larger tubercles.

Height $\frac{7}{10}$ ths of an inch, diameter $\frac{11}{10}$ ths of an inch.

This pretty little Urchin was first described by Prof. Goldfuss from specimens named by Count Münster from the Oolites of Baireuth ; the hemispherical test exhibits a disposition to assume a subpentagonal circumference from the greater prominence of the ambulacral areas ; the surface of the test is divided into fifteen nearly equal lobes by the ten poriferous avenues, and the five depressions which divide the interambulacra down their mesial lines ; these lobular divisions are more defined in young and small specimens than in large and old ones ; the ambulacral areas are one half the width of the interambulacral, and have nine large tubercles at their base, and four or five rows of small tubercles at their widest part, which gradually diminish to three, two and one as we approach the apex of the area ; the interambulacral areas are twice the width of the ambulacral, they have about twenty-four large tubercles at their base, and about twelve rows of small tubercles at their widest part, which gradually diminish by the disappearance of the external rows to ten, eight, six, four and two, as we trace the rows from the equator to the apex of the areas ; the tubercles on the sides and upper surface of the test are nearly of a uniform size, they are arranged in rows, the tubercles are opposite each other and do not alternate as in some other genera. The interambulacral areas are each divided by a slightly depressed line into two lobes ; these are separated from the ambulacral areas by straight narrow poriferous avenues, so that the test of this beautiful Urchin appears to consist of fifteen nearly equal lobes, those of the ambulacra being the most prominent and best defined, in consequence of the

depth of the poriferous avenues being greater than the sulcus which divides the interambulacra.

The mouth is large and decagonal, and lies in a concave depression in the base, surrounded by the larger tubercles which occupy this region of the test. The ovarian plates are small, and form a rather prominent ring around the anal opening; the eye-plates are small, but in some of the foreign individuals now before me the eye-holes are very distinct.

Affinities and differences.—This Urchin resembles *Arbacia Forbesii*, but may be distinguished from that species by having the ambulacral areas proportionately wider, the tubercles larger and opposite to each other, and the poriferous avenues having the pedal holes in triple oblique pairs; it belongs moreover to a newer rock of the Oolitic series.

Locality and stratigraphical range.—We know only one English specimen of this species, which was found in the Cornbrash by Mr. Bay near Sutton Benger, Wilts; on the continent it occurs in the Baireuthian Jurakalke, where it was found by Count Münster. It has been collected from the Great Oolite of Langrune by Prof. Deslongchamps and M. Tesson, and from the Calcaire à polypiers at Ranville by M. Michelin. We beg to record to each of these gentlemen our best thanks for the beautiful series of type specimens of this Urchin with which they have so liberally supplied us.

History.—Figured and described for the first time by Goldfuss. We are not aware that any detailed description of the species has been given before, with the exception of the very brief one contained in the 'Petrefacta Germaniæ.'

Polycyphus Deslongchampsii, Wright. Pl. II. fig. 4, a-e.

Test hemispherical, circumference circular; ambulacral areas with two rows of larger and two rows of smaller tubercles; interambulacral areas with two rows of larger and several rows of smaller tubercles; the small tubercles in both areas often degenerating into mere granulations; basal tubercles large and prominent.

Height $\frac{7}{10}$ ths of an inch, transverse diameter $\frac{1}{2}$ ths of an inch.

Description.—Amongst the many beautiful forms of Urchin structure, this pretty little species will bear comparison for neatness and symmetry with any of the family to which it belongs. We found the first specimen about eighteen months ago, and since then have added an interesting series to our collection. It must be a rare form, as only two or three specimens have been obtained besides those collected by ourselves. The ambulacral areas are one half the width of the interambulacral, and have one row of

tubercles on each side of the margins of the area, between these are several rows of small granulations arranged without much order; at the base of the area ten larger tubercles are disposed in pairs, the tubercles on the right side alternating with those on the left; the interambulacral areas are about twice the width of the ambulacral; a single row of tubercles occupies the centre of each of the two columns of plates, and numerous smaller tubercles degenerating into mere granules cluster around the base of the large tubercles; a second row of tubercles extends upwards from the basal angle towards the equator, where it terminates; the basal tubercles consisting of about six pair occupy all the base of the area—they are about the same size as those of the ambulacra, but are arranged somewhat less regularly. The median depression in the centre of the interambulacra is very well marked in this species, so that the test has the appearance of being divided into fifteen lobes. The anal plates form a prominent narrow ring around the oblong anal opening, and the eye-plates are closely soldered to them; the eye-holes are very distinct in most of our specimens. The mouth-opening is of moderate size, and is slightly decagonal; the poriferous avenues lie in considerable depressions of the test, which throws the ambulacral areas into prominent relief from the interambulacra.

Affinities and differences.—The marginal rows of tubercles on the ambulacra, and the central rows of tubercles on the plate columns of the interambulacral areas serve to distinguish this species from *P. nodulosus*. It has a considerable resemblance to the young forms of *Echinus germinans*, but the regularity of the rows of tubercles on the sides and upper surface of the test, and the size and arrangement of those at the base afford good diagnostic characters by which it may be easily distinguished from that common form; the same group of characters serves to distinguish it from *Arbacia Forbesii*.

Locality and stratigraphical range.—We have only found this species in the Pea-grit of Crickley Hill; all the other specimens that were collected by Mr. Gibbs of the Geological Survey, were found in the same bed of this locality.

We dedicate this fossil to Professor Deslongchamps of Caen, to whom palæontology is indebted for many important contributions to the Oolitic fauna published in the 'Mémoires de la Société Linnéenne de Normandie.'

Nucleolites Woodwardii, Wright, 1852. Pl. II. fig. 5, *a-e*.

Test subquadrate, sides tumid, dorsal surface flatly convex, anal valley deep, narrow and spear-shaped, extending from the apical disc to the posterior border; ambulacral areas narrowly

lanceolate; posterior lobes short and truncated; base flat; antero-interambulacra and postero-interambulacra slightly swollen at their base; the single ambulacrum scarcely produced; mouth-opening pentagonal, situated anteriorly; apical disc small and nearly central.

Height $\frac{6}{10}$ ths of an inch, antero-posterior diameter 1 inch and $\frac{1}{10}$ th, transverse diameter 1 inch and $\frac{2}{10}$ ths; the larger specimens are so much deformed by pressure that their proportional dimensions cannot be accurately given.

Description.—Some individuals of this species were formerly considered by us to be only varieties of *Nucleolites orbicularis*, Phil., but a better knowledge of the structure of this Urchin, derived from the study of a series which we collected last summer and have carefully compared with good typical examples of *N. orbicularis*, leaves no doubt about the distinctness of *N. Woodwardii* from that Cornbrash form. The test is thin and not often sufficiently well preserved for determining the species; the one which we have figured is a small but a very perfect specimen, it has a subquadrate outline and is $\frac{1}{10}$ th of an inch broader than it is in the antero-posterior diameter; it is slightly narrower anteriorly than posteriorly, and (which is more apparent when it rests upon its dorsal surface) the posterior margin is seen to be broadly truncated; the sides are tumid, sometimes irregularly so, and the test is higher across the apices of the postero-lateral ambulacra than at any other point; the tumidity of the sides produces a greater flatness of the dorsal surface than we observe in any other of the small *Nucleolites* of the Oolitic rocks; the ambulacral areas are nearly all of the same width, they have a narrow graceful lanceolate form, from the mouth to about midway between the margin and the apical disc, they are nearly of equal width; at this point the pores gradually change their form, and are slightly separated apart for a short distance, and begin again to converge as they approach the disc; the internal row are circular, the external in the form of oblique slits, the widest part of which is outwards, the circles are formed by notches in the upper and under sides of the small ambulacral plates, and the oblique slits by uncalcified portions of the margins of the same plates; from the termination of the petaloid portion of the ambulacral areas to the mouth, the pores are small and set wider apart, whilst the diameter of the areas remains about the same; near the mouth-opening they are again more closely crowded together, and terminate in arches the convexity of which look towards that aperture; the interambulacral areas are of unequal width; the anterior pair are the narrowest, the posterior pair are wider than the anterior, and the single interambulacrum is the widest;

the anal valley is a long narrow depression extending from the apical disc to the margin, it has perpendicular sides and a small anal opening, the base is flat and only slightly depressed at the mouth; the anterior and posterior pairs of interambulacra are moderately convex in this region, and the basal portion of the single interambulacrum is very slightly produced; the mouth-opening is excentral, nearer the anterior margin, it has a pentagonal form with five rudimentary lobes. The surface of the test is covered with microscopic tubercles requiring a good lens to distinguish them; these bodies are only a little larger at the base of the test; the apical disc is small and nearly central, its elements are so closely soldered together that its general form can alone be distinguished; the eyeholes are situated at the apices of the ambulacra, and the ovarial holes further outwards and between them, whilst the madreporiform tubercle occupies the centre of the disc; the test is very thin and often deformed, its upper surface having sometimes an irregular appearance. The beauty and regularity of the specimen figured forms an exception to all the others we possess of this species.

Affinities and differences.—*Nucleolites Woodwardii* most nearly resembles *N. orbicularis*, and is the only one among its Oolitic congeners for which it could be mistaken. The following characters are diagnostic of *N. Woodwardii*. The tumidity of the sides and flatness of the dorsal surface, both of which are absent in *N. orbicularis*. In our species the base is flat and the interambulacra are slightly produced, whilst in *N. orbicularis* the base is concave and the interambulacra are convex and prominent. In *N. Woodwardii* the anal valley is narrow, whilst in *N. orbicularis* it is wide; the general outline of our species is subquadrate, that of the *N. orbicularis* is circular; the petaloid arrangement of the ambulacral areas extends downwards nearer to the margin in *N. orbicularis* than in *N. Woodwardii*; the narrowness of the anal valley in our species establishes an affinity between it and *Chelypeus altus*, M'Coy; but the flatness of the base and the depression of the dorsal surface in *N. Woodwardii*, make a wide distinction between it and that species, which has a high convex dorsal surface and extremely prominent basal interambulacra, with a greatly produced interambulacrum; it differs from *N. Hugii* in having the anal valley extended from the disc to the posterior margin, whilst in that species a portion of the test intervenes between the disc and the valley; the difference between *N. Woodwardii* and *N. scutatus* and *N. clunicularis* is so great, that it is scarcely possible that *N. Woodwardii* can be mistaken for either of these forms.

Locality and stratigraphical range.—We have collected this Urchin from the Great Oolite near Cirencester and at Salperton Tunnel, Great Western Railway, and from beds of the same age

near Pewsdow, Gloucestershire, and near Burford, Oxon; it has likewise been found near Minchinhampton: as far as we know, it appears to be a Great Oolite species.

We dedicate this species to our friend Mr. S. P. Woodward, of the British Museum, to whose kindness we are much indebted for the privilege of comparing our specimens with the magnificent series of Echinodermata under his care, and which he has rendered so valuable for reference by a systematic classification and a correct nomenclature.

Nucleolites Michelini, Wright. Pl. II. fig. 6, *a-c*.

Test circular or oblong, discoidal and much depressed, posterior border produced, truncated and slightly deflected in old individuals; ambulacral areas narrowly lanceolate; pedal pores closely set together, vertex and apical disc nearly central; anterior half of the dorsal surface convex, posterior half much declined from the vertex to the posterior border; anal valley narrow above, diverging below, extending from the apical disc to the border; base flat, slightly concave; mouth excentral, margin with five small lobes; postero-lateral interambulacral areas slightly tumid at the base.

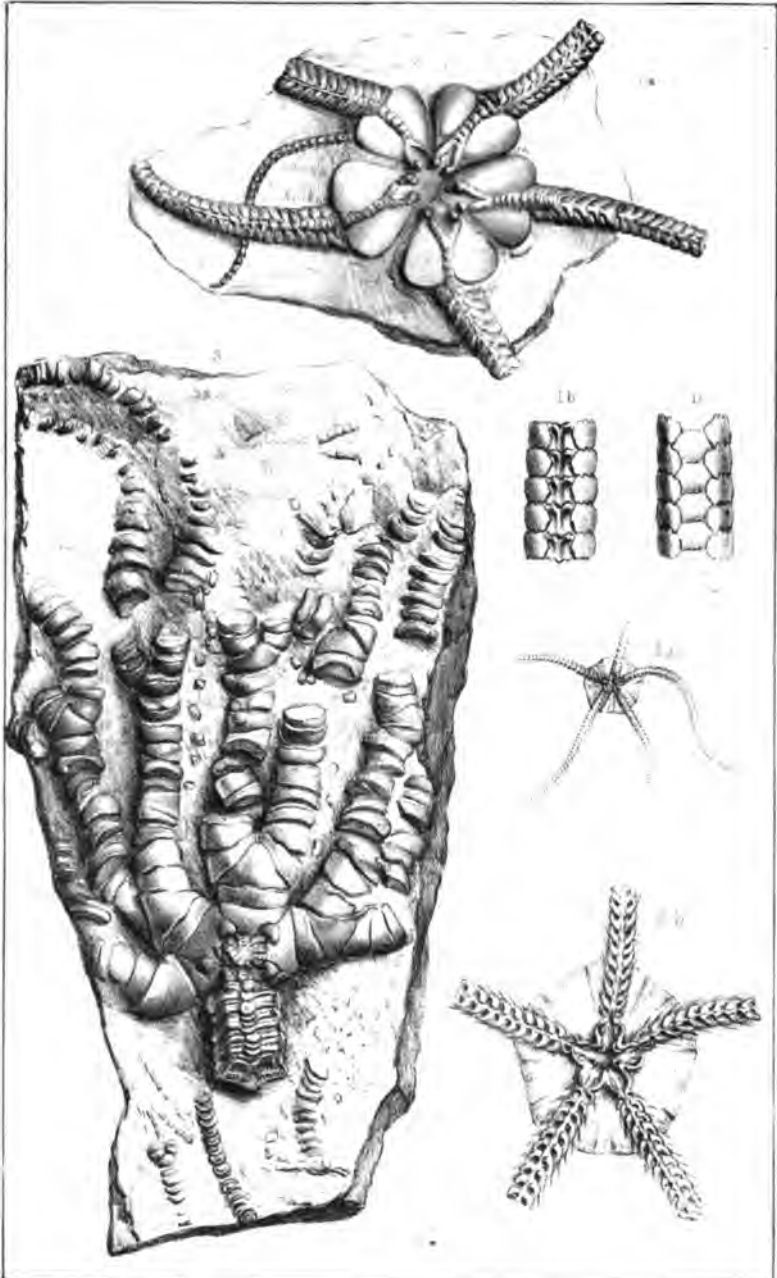
Height $\frac{2}{10}$ ths of an inch, antero-posterior diameter 3 inches and $\frac{2}{10}$ ths, transverse diameter 2 inches and $\frac{2}{10}$ ths of an inch.

Description.—The outline of this Urchin varies in different individuals, and it likewise varied at different periods of life in the same individual; its most typical form is oblong, convex anteriorly, produced and truncated posteriorly, and swollen out in the region of the postero-lateral interambulacra; in others the circumference is nearly circular, and in some it is transversely oval; the first form is we think characteristic of adult life, as the production and truncation of the single interambulacrum were markedly shown in the only two large specimens of this rare species which we have seen; in all the test is very flat, the anterior half is gently and nearly equally convex, the posterior half is sloping and much declined in the direction of the posterior border. The ambulacral areas are narrow, the anterior one most so; the antero-lateral and postero-laterals are about the same width, they have a lanceolate form, and are composed of very narrow plates; about $\frac{3}{10}$ ths of an inch above the margin, the pores slightly diverge from each other, and continue apart until they approach the apical disc; the distance between the rows of pores in this species is less than in any other Nucleolite of the same size we know, and forms one of the characters by which it is distinguished from its congeners; the ambulacral areas are likewise slightly elevated above the general surface of the test in

all the specimens we have examined; the interambulacral areas are of unequal width, the antero-lateral pair are the narrowest, they are however about nine times the width of the anterior single ambulacral area; the postero-lateral pair are $\frac{3}{10}$ ths of an inch wider than the antero-laterals, and the single interambulacrum is about the same width as the latter. The anal valley extends from the apical disc to the posterior border; it is very narrow, with deep perpendicular sides above, which become shallow and expanded below; the postero-lateral interambulacra are swollen out at the margin; the single interambulacrum is considerably produced, and its posterior border is broadly truncated and slightly deflected, within which the expanded sides of the anal valley are excavated. The base is nearly flat, the elevations are due to the prominence of the postero-lateral interambulacra, and to the deflection of the single interambulacrum. The mouth is excentral, nearer the anterior margin, and the oral lobes are small; the apical disc was of moderate size, judging from the space it occupied, but it is absent in all our specimens; the surface of the test was covered with very minute tubercles, which in the examples before us are nearly all effaced.

Affinities and differences.—*N. Michelini* in its oblong form, truncated posterior margin, and narrow anal valley resembles *N. Solodurinus*, but it is readily distinguished from it by the form, narrowness, and structure of the ambulacral areas; in *N. Solodurinus* they are expanded and petaloid, and in *N. Michelini* they are narrow and lanceolate; the pores at no point are at any great distance apart; the anal valley in both species extends from the apical disc to the margin, but it is more expanded below and deeper above in *N. Michelini* than in *N. Solodurinus*. We have before us *Chypeus angustiporus*, Agass., from a coarse Oolitic rock (Bradfordien?) near Metz, collected by M. Terquem, and kindly sent us by M. de Lorière; from this species *N. Michelini* differs in many particulars; in the French Urchin the apical disc is excentral, the anal valley is wide above and not much expanded below, the ambulacral areas are narrow, and the test gradually declines from the vertex to the anterior border, which forms a rather acute angle; the base is undulated, and the mouth-opening is nearly central; these characters clearly distinguish our Urchin from it. *N. Michelini* differs so widely from all the various varieties of *N. sinuatus* with which we are acquainted, that it cannot possibly be mistaken for either of them, if any care be taken when a comparison is made between them.

Locality and stratigraphical range.—We have collected this species only from the Freestone beds of the Inferior Oolite of Wallsquarry and Nailsworth; the specimen figured was cut out of the centre of a block of building stone; the oolitic grains are



W H Baily

- 1 a, c Ophioderma Gavev;
 2 a, b Oriesbachii
 3 Pentacrinus Goldfusi

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imbedded in the plates of the test, and have in some measure injured the surface.

We dedicate this species to M. Michelin of Paris, the distinguished author of the 'Iconographie Zoophytologique,' as a tribute of gratitude for the valuable collection of Echinoderms he liberally and generously sent us from his unrivalled cabinet, to facilitate our studies of these beautiful forms of ancient life.

Nucleolites scutatus, Lamarck.

Since the publication of our memoir on the *CASSIDULIDÆ* of the Oolites*, we have received from Professor Deslongchamps and M. Tesson a series of type specimens of *Nucleolites scutatus* from the Coral Rag of Trouville, Calvados, which we have compared with *Nucleolites dimidiatus*, Phillips, described in that memoir; from this comparison it is certain, that our Wiltshire and the Yorkshire Nucleolite, figured by Professor Phillips as *N. dimidiatus*, is the true *N. scutatus* of Lamarck. This circumstance affords another example of the great importance of comparing all our British Oolitic fossils with those collected from the Jurassic strata of the continent of Europe, before assigning them a position in our catalogues of species.

Ophioderma Gaveyi, Wright, 1852. Pl. III. fig. 1 a-c.

Diagnosis.—Disc large, upper surface not exposed, under surface with five pairs of heartshaped plates, above which the five rays pass; the median scutal plates of the rays form a ridge in the centre of each pair of plates; the mouth-opening is surrounded with five pairs of very prominent toothlike processes; the rays are slender and gently tapering; the central scutal plates on the dorsal and ventral surfaces of the rays are narrow, those on the ventral surface resemble the bodies of small vertebræ deprived of their neural elements.

Transverse diameter of the body-disc 1 inch and $\frac{2}{10}$ ths, transverse diameter of the rays at their junction with the disc nearly $\frac{5}{10}$ ths of an inch.

Description.—This Sea-star must have been rather abundant in the Liasic sea; we have seen many fine specimens of it, and numerous fragments of others in the locality where it was collected. The body-disc is large and pentagonal, it is composed underneath of ten thin, delicate triangular plates arranged in pairs, each pair forming a heartshaped shield, having an elevated rugose carina down its centre, formed by the median element of the ventral scutal plates which protrudes between each of the two plates forming a pair; the five shields are otherwise smooth

* Annals of Natural History, vol. ix.

on their under surface, and were united together in the living state by a membrane, but in the specimen before us they are quite separate from each other; at the apex of each of the ten triangular plates a sharp toothlike process projects downwards, which together form an imposing dental circle around the mouth-opening. The rays are long, slender, and gently tapering; we have not been able to measure the absolute length of one, as those which we have met with were always fractured; the dorsal median pieces of the rays are hexagonal and elongated transversely, the ventral median pieces are elongated in the direction of the length of the ray, and resemble the bodies of small vertebræ which had been deprived of their neural arches; the marginal plates are rounded and finely imbricated, their outward free border is toothed with five or six pectinated processes, which in the living state supported as many spines; the remains of these are sometimes seen attached to their supports; the lateral scutal plates clasp the rays firmly and securely, and overlap the median pieces both above and below.

Affinities and differences.—This elegant Sea-star somewhat resembles in its general contour *Ophioderma Milleri*, but it is distinguished from that marlstone species by having a proportionately larger body-disc, with more slender and more tapering rays: in the form and structure of the scutal elements of the rays themselves there is likewise a difference, those in *O. Milleri* are of a more elongated and regular form, whilst in *O. Gaveyi* they are shorter, more ridgy and vertebrate-like; the ten triangular ventral discal plates are smaller in *O. Milleri* than in *O. Gaveyi*; they want likewise, in the figures given by Mr. Charlesworth in the London Geological Journal, the toothlike spines at their apices which are so characteristic of our *Ophiura*.

Locality and stratigraphical range.—This Sea-star was collected by Mr. Gavey from the upper shales of the Lower Lias at Mickleton Tunnel near Chipping Campden, Gloucestershire, whilst making the Oxford, Worcester and Wolverhampton Railway; and we have found some fragments of a Sea-star much resembling in structure this species in a Liasic bed of the same horizon at Hewlitt's Hill near Cheltenham, during the excavation of the new reservoir of the Water Works Company of that town.

We dedicate this species to our friend Mr. G. E. Gavey, whose careful and minute investigation of the beds exposed in the section which he has so well described*, added to the discovery of new forms of Radiata and Mollusca in the same, has enriched our knowledge of the Liasic fauna of Gloucestershire.

* Railway Cuttings at Mickleton Tunnel and Aston Magna, by G. E. Gavey, Quart. Journ. Geol. Soc. February 7, 1853.

Ophioderma Griesbachii, Wright. Pl. III. fig. 2 *a*, *b*.

Diagnosis.—Body-disc small, upper surface not exposed, under surface irregularly subpentagonal, formed of five pairs of heart-shaped plates; rays long, slender, and awl-shaped, prolonged beneath into the centre of the body-disc; inferior surface with median vertebrate-like elements, and lateral scutal plates in the form of oblique pyramidal pieces, which clasp the sides of the rays in an imbricated manner, and support at their terminal points short stout spines; mouth subpentagonal, surrounded by ten blunt spinous processes, formed by the development of the first lateral scutal plates of the rays, where they join each other around the mouth.

Diameter of the body-disc $\frac{7}{80}$ ths of an inch, length of the rays from the mouth-margin to their apex $\frac{1}{2}\frac{1}{8}$ ths of an inch.

Description.—This beautiful Brittle-star of the Oolitic sea was discovered by our friend the Rev. A. W. Griesbach, of Wollaston, and we owe to his kindness and liberality the series of exquisite specimens before us, by which we have been enabled to complete the description of this new fossil. The body-disc is small, consisting of five pairs of heart-shaped plates; the union between the separate elements of the disc was very intimate, as it is only at one or two points that a suture is exhibited; so close is the union, that in other specimens the body-disc seems to be formed of a single circular element; each pair of plates has a heart-shaped form, and the ray corresponding thereto stands out in bold relief from the under surface of the disc. In none of the specimens found is the upper surface of the disc exposed, and we know not with certainty what kind of ornamentation adorned its dorsal surface; at one part, however, where a portion of one of the plates is weathered, we think we detected with our inch object-glass under the microscope, a series of small imbricated scales resting on the rock surface; the rays are long, slender, and gently tapering; their under surface, the only one exposed, exhibits, 1st, a central element having an elongated form, which resembles the body of a fish's vertebræ in miniature; 2nd, lateral elements more largely developed, consisting of triangular plates of a pyramidal form slightly twisted round, by which arrangement the apices of the pyramids are made to clasp each other, and thereby produce a regular imbricated structure; the points of the lateral plates support small, short, stout spines, which are only seen in one of the rays of the three specimens before us. Where the base of the ray crosses the under surface of the body-disc it is firmly attached thereto, and as they approach the centre, each of the lateral plates of the rays becomes greatly developed, and form by their union five channels, which

extend into the mouth; this opening is in the centre of the disc, and has a subpentagonal form; it is of a moderate size, and is surrounded by ten stout spines formed by the development of the first lateral plates, which are much expanded and terminate at the oral border in short stout spinous processes; the lateral plates from the adjoining rays are here united together, so that two spines from the lateral plates of different rays are closely approximated, and the five rays are thereby united together round the mouth-opening like five Gothic arches, so that the mouth with its channels, formed by these arches, resembles a miniature starfish in the centre of the disc; the five pairs of spines may have served as jaws.

Affinities and differences.—Our knowledge of fossil *Ophiurida* is unfortunately so limited, and the details of those forms known are so meagre, that there is much difficulty in making a comparison between the extinct genera of this family. In our description of *Ophioderma Gaveyi* a diagnosis has been attempted between it and *O. Milleri*, Phil., both of these being Liasic species. The other forms hitherto published are those figured by Goldfuss, namely the *Ophiura prisca*, Münster, from the Muschelkalk of Baireuth; the *Ophiura loricata*, Goldf., from the Muschelkalk of Würtemberg; the *Ophiura speciosa* and *O. carinata*, Münster, from the Lithographic slates of Solenhofen; of these Goldfuss's figures are excellent, and leave nothing to be desired, as that able natural-history artist Herr Hohe, whose crayon has added such lasting value to the 'Petrefacta Germaniæ,' has given accurate details of structure which prevent the possibility of confusion regarding the identification of the species drawn by him.

The *Ophiura Egertoni*, Brod.*, found in nodules of micaceous sandstone at the base of the Inferior Oolite near Charmouth, is so entirely distinct from our fossil, that to mistake them is impossible; between *O. Griesbachii* and *O. speciosa* and *O. carinata*, the difference is likewise very great; *O. loricata* comes nearer to our Brittle-star than either of the others, but the great development of the lateral plates of the rays, and the clasping and imbricated character of the same in *O. Griesbachii*, forms a structural character which separates it widely from Goldfuss's species. If we seek further for resemblances to our Brittle-star, we must look for them more amongst the beautiful *Ophiocomæ* of our seas than among any forms we are acquainted with in the fossil state, but even between it and them the differences are many and distinct.

Locality and stratigraphical range.—This beautiful fossil was collected by the Rev. A. W. Griesbach from the Forest marble of

* Geol. Trans. 2nd series, vol. v. pl. 12.

Oundle, Northamptonshire, where it is rare. We have dedicated this species to that gentleman, to whom we are indebted for much valuable information relative to the stratigraphical distribution of Echinoderms in his county, and likewise for a liberal contribution of materials to aid us in the completion of these memoirs.

Pentacrinus Goldfussii, Wright. Pl. III. fig. 3.

Diagnosis.—Calyx composed of a central pentagonal plate, five small heart-shaped pieces, and five large triangular basal elements; rays thick, strong and bifurcated; total number of their subdivisions unknown; the five primary rays consist of two pieces, the basal piece is flat, and has a slightly elevated portion about the centre of the upper surface, the brachial piece is strong and triangular, its base resting firmly on the former; the sides of the triangle support two arms; the ten secondary rays consist of from ten to eleven circular pieces with smooth unequal undulated surfaces, whereby their thickness is rendered very unequal; the secondary rays support twenty tertiary rays, which have the same general character as the secondary rays; the number of pieces entering into the composition of each is unknown; from the fragmentary state of this part of the specimen the number may be estimated at from fifteen to twenty pieces. The column near the calyx is composed of thin, deeply divided five-rayed plates, with well-marked transverse articular impressions on their surfaces; every fourth plate is thicker, broader, and more prominent than the one above it or below it; the side arms are numerous, and composed of thin circular plates: the lower part of the column is unknown.

Description.—This beautiful Sea Lily is remarkable among its Liasic congeners for the comparative strength and thickness of its rays; the centrum of the calyx is simply a thickened and enlarged columnar joint to which the upper part of the column is articulated; around the apices of the rays of this centrum five small heart-shaped basal pieces are inserted, the points of which are directed outwards; they are very convex externally, projecting from the surface of the calyx, and have the appearance of five mammillary eminences disposed around the union of the column with the calyx.

The rays are short and robust; the primary portion consists of two pieces, a flat basal plate and a triangular brachial plate; the basal plate has a slight elevation on its outer and upper articular surface; the brachial plate has the form of an equilateral triangle, it is very convex externally, and has its base firmly

planted on the flat basal plate, and its sides support the secondary rays; these are ten in number, and consist of from ten to eleven circular plates, each differing in form and thickness from the other, their articular surfaces being smooth and undulated in different directions, the elevations of the one plate always corresponding to the depressions of the other with which it is articulated; these inequalities are well seen in the specimen before us; from the various angles at which these plates lie in relation to each other, the ultimate brachial piece of each of the secondary rays has a triangular form externally, the sides of which support the tertiary rays; these, like the secondary rays, consist of unequal-sized plates with undulated articular surfaces, which are marked with fine lines that radiate from the centre to the circumference; the number of the elements in these tertiary rays cannot be accurately made out in consequence of the imperfection of this part of the skeleton; judging however from the remains of the plates in a part of the slab once occupied by a tertiary ray, we estimate their number to have been from fifteen to twenty. The inferior surface of the centre of the calyx exhibits a depression produced by the convexity of the brachial elements and the prominence of the heart-shaped basal pieces; into this depression the summit of the column closely fits. It is unfortunate that so small a portion of the column of this Crinoid is preserved, as it is possible that the lower part of the stem was different from that which is preserved; the upper part of the column before us consists of thin star-shaped plates, the rays of which are deeply divided, and their surfaces are sculptured with well-marked transverse articular processes; between every third plate a thicker and broader plate is introduced; the side-arms appear to have been numerous about the upper part of the column; they were composed of thin circular plates having undulated surfaces similar to those observed on the secondary and tertiary rays.

Affinities and differences.—*Pentacrinus Goldfussii* resembles in some points *P. tuberculatus*, Mill.: through the kindness of Major Austin and Mr. Etheridge we had the privilege of comparing our fossil with Miller's type specimen in the Bristol Museum, but the imperfection of that Crinoid makes a rigorous comparison impossible; one point of difference which Miller thought specific of *P. tuberculatus* he thus describes: "The column differs in its joints, being thinner, and their having been covered all over with a more conspicuous muscular coat, which shows itself in numerous minute tubercles the result of its contraction*:" this character is certainly absent in our fossil. It is distinguished from

* Miller's Crinoidea, p. 65.

P. briareus, Mill., *P. subangularis*, Mill., and *P. scalaris*, Goldf., by the absence of lateral branches from the rays, and from all others of its Liasic congeners with which we are acquainted in the strength and thickness of the rays themselves.

Locality and stratigraphical range.—This remarkable Sea Lily was discovered by Mr. R. E. Gavey, C.E., in the Lower Lias of Mickleton Tunnel near Chipping Campden, Gloucestershire; it is imbedded in shale resting on a hard slab of limestone, and was associated with the remains of other Radiata.

We dedicate this fine Liasic Crinoid to the memory of the late Prof. Goldfuss, whose great work, 'Petrefacta Germaniæ,' has so much increased our knowledge of the Liasic and Oolitic fauna.

A Tabular View of the Stratigraphical Distribution of the New Species described in this Memoir.

Genera and Species.	Authority.	Lower Lias.	Marlstone.	Upper Lias.	Inferior Oolite.	Great Oolite.	Cornbrash.	Forest Marble.	Coralline Oolite.
<i>Cidaris Edwardsii</i>	Wright ...	*							
— <i>Bouchardii</i>	Wright ...	...	...	...	*				
<i>Hemicidaris minor</i>	Agassiz ...	...	...	...		*			
<i>Acrosalenia crinifera</i>	Quenstedt	*							
<i>Diadema Davidsoni</i>	Wright ...	...	...	...	...	...	...	...	*
— <i>Moorei</i>	Wright ...	...	...	*					
<i>Pedina Bakeri</i>	Wright ...	...	...	*	*				
— <i>Etheridgii</i>	Wright ...	...	...	*	*				
<i>Polycyphus nodulosus</i> ...	Münster ...	...	...	...	...	*	*		
— <i>Deslongchampsii</i> ...	Wright ...	...	...	...	*				
<i>Nucleolites Woodwardii</i> ...	Wright ...	...	...	...	...	*			
— <i>Michelini</i>	Wright ...	...	...	...	*				
— <i>scutatus</i>	Lamarck...	...	...	...	...	...	...	...	*
<i>Ophioderma Gaveyi</i>	Wright ...	*							
— <i>Griesbachii</i>	Wright ...	...	...	...	...	...	*		
<i>Pentacrinus Goldfussii</i> ...	Wright ...	*							

EXPLANATION OF PLATES I. II. AND III.

PLATE I.

- Fig. 1. *Cidaris Edwardsii*: *a*, natural size, and restored to its globular form; *b*, portion of an ambulacral area magnified, showing the pedal pores and tubercles; *c*, primary tubercle, with its circle of areal granules, magnified; *d*, one of the jaws and its tooth, of the natural size; *e*, secondary spine, natural size and magnified; *f*, primary spines, natural size and magnified.
- Fig. 2. *Cidaris Bouchardii*: *a*, *b*, natural size; *c*, primary tubercle and ambulacral area, magnified.
- Fig. 3. *Hemicidaris minor*: *a*, natural size; *b*, magnified two diameters; *c*, primary tubercle and ambulacral area, magnified.
- Fig. 4. *Pedina Bakeri*: *a*, natural size; *b*, magnified one and a half diameter; *c*, primary tubercle and ambulacral area, magnified.
- Fig. 5. *Pedina Etheridgii*: *a*, natural size; *b*, upper surface and ovarian plates, magnified two diameters; *c*, under surface and mouth-opening, magnified two diameters; *d*, primary tubercle and ambulacral area, magnified.

PLATE II.

- Fig. 1. *Acrosalenia crinifera*: *a*, natural size; *b*, upper surface, magnified three diameters; *c*, under surface, magnified three diameters; *d*, primary tubercle and lateral granules, magnified.
- Fig. 2. *Diadema Davidsoni*: *a*, under surface and mouth-opening, natural size; *b*, upper surface and anal opening, natural size; *c*, side view, showing the tubercles of both areas; *d*, base of one of the ambulacral areas, showing the clustering together of the pedal pores in this region; *e*, primary tubercle, ambulacral area, and pedal pores, magnified.
- Fig. 3. *Diadema Moorei*: *a*, natural size; *b*, upper surface and ovarian disc, magnified two diameters; *c*, under surface and mouth-opening, magnified two diameters; *d*, primary tubercle, circle of granules, and pedal pores, magnified.
- Fig. 4. *Polycyphus Deslongchampsii*: *a*, natural size; *b*, upper surface and ovarian disc, magnified one and a half diameter; *c*, outline of the mouth-opening; *d*, genital and ocular plates of the ovarian disc, magnified; *e*, primary tubercle, areal granules, pedal pores, and ambulacral area enlarged.
- Fig. 5. *Nucleolites Woodwardii*: *a*, upper surface, of the natural size; *b*, side view, of the natural size; *c*, ambulacral area and pedal pores, magnified two and a half diameters; *d*, tubercles and areas, magnified; *e*, mouth-opening and ambulacral area, magnified one and a half diameter.
- Fig. 6. *Nucleolites Michelini*: *a*, upper surface, reduced one-third in size; *b*, lateral view, reduced one-third in size; *c*, a portion of the ambulacral area and pedal pores, natural size.

PLATE III.

- Fig. 1. *Ophioderma Gaveyi*: *a*, disk, with portion of the rays, natural size; *b*, part of the upper side of a ray, enlarged three diameters; *c*, under side, enlarged three diameters.
- Fig. 2. *Ophioderma Griesbachii*: *a*, natural size; *b*, disk and a part of the rays, enlarged three diameters.
- Fig. 3. *Pentacrinus Goldfussii*: natural size.

Upon a new species of "Alpheus" discovered upon the coast of "Herm" (Channel Islands). By W. V. GUISE, Esq., F.G.S.

READ 9TH MAY 1854.

IN the course of an excursion to the Channel Islands, undertaken last summer with a view to natural-history pursuits, I spent three days in the little islet of Herm, which, though a mere rock, scarcely three miles in circumference, is equalled by few spots of similar extent within the area of the British seas, in respect of the rich field it offers for the researches of the marine naturalist.

The Channel Islands, though an appanage of the crown of Great Britain, are, geographically speaking, rather a part of France than of England; and this situation, in a sort of debatable ground, may perhaps in some degree account for the fact of their natural history having been to a certain extent overlooked by the naturalists of both countries; though few districts can be expected to yield a richer harvest to the scientific investigator, constituting as they do the northern limit to many Mediterranean forms, which, here found flourishing in full vigour, and showing no signs of decrepitude, dwarfishness or decay, suddenly disappear, and find no footing upon our side of the Channel. This is well known to be the case amongst the testaceous Mollusca; and there is little reason to doubt, that researches prosecuted amongst the other kingdoms of nature would be rewarded by the discovery of many novel and important facts.

Amongst the Crustacea, to which I propose especially to direct your attention, it is only necessary to refer to the discovery of the singular and beautiful "*Phyllosoma sarniense*," figured and described by Mr. C. F. Lukis in the 8th volume of 'London's Magazine of Natural History,' which example, still I believe unique, has its only analogues in one Mediterranean species, and in a few others confined to tropical areas.

I propose now to lay before you another Crustacean, which it has been my good fortune to obtain in a tide-pool at low water on the islet of Herm, and which, from its immediate recognition as the "red shrimp" by the fisherman who accompanied me, I have reason to believe is not of unfrequent occurrence. My first idea was, that I had obtained "*Alpheus ruber*," itself a great

prize, being a Mediterranean species of the greatest rarity in our seas; but upon comparing it carefully with the descriptions of Milne-Edwards in his 'Histoire Naturelle des Crustacés,' I became convinced that I had had the good fortune to obtain an entirely new species of *Alpheus*; and further investigations have only tended to confirm me in that opinion.

The genus "*Alpheus*" is thus characterized by Milne-Edwards:—

Carapace prolonged in form of a hood or vault over the eyes.

Rostrum small, and sometimes wanting.

Superior antennæ small; first articulation short, and armed without with a plate, generally spiniform; two following joints cylindrical, having two terminal threads, of which the superior is thicker and shorter than the inferior, and presenting traces of a division into two filaments towards the end.

Inferior antennæ inserted without and below the preceding.

Lamellar palp of moderate size, sometimes small and pointed.

Mandibles provided with a short, broad, palpiform appendage.

External pedipalps more or less slender and elongated, termination broad and somewhat foliaceous.

Two first pairs of legs didactyle, the first pair strong; the one much larger and more robust than the other.

Second pair weak and filiform, having the wrist multi-articulate.

Three last pairs of legs monodactyle and of moderate length.

This genus, says M. Edwards, appears to belong properly to the seas of warm climates. Some species are found in the Mediterranean; but the greater part come from the seas of the Antilles or from the Indian Ocean.

The genus is *divided* into those which *have*, and those which *have not*, a *spiniform rostrum*. It is further *subdivided* into those having a spine attached externally to the basal joint of the *external antennæ*, and those *not* so furnished.

The example now before us will be found to belong to the second subdivision of the first division, *i. e.* to those provided with a pointed beak, and not having an external spine at the base of the *external antennæ*.

Under this head three species are described by M. Edwards as inhabiting the European seas, *viz.*—

Alpheus ruber, *Alpheus Edwardsii*, and *Alpheus dentipes*, which are characterized as follows:—

Alpheus ruber. "Body very slender; larger hand provided with four longitudinal carinæ, two on the upper edge, two on the

external face; lower margin obtuse; moveable finger *much shorter* than the immoveable one. A spine upon the upper margin of both arms at some distance from the termination."

It will be remarked that nothing is here said concerning the character of the anterior portion of the carapace; but as this species is said to be "très voisine de la précédente" ("*Alpheus brevirostris*," a new Holland species), which is characterized as having the border of the supra-orbital hood rounded and *without spines*, it is to be inferred that the like character also applies to *A. ruber*.

Alpheus Edwardsii. "Very closely allied to the preceding. *Anterior* borders of *supra-orbital vaults* armed with a *spine*, so that the front presents three nearly equal teeth. The second joint of the superior antennæ about half as long again as the first. Lamellar appendage of the external antennæ dilated a little within towards the end, and not passing the footstalk of the superior antennæ. Pedipalps very narrow towards the end, and extending beyond the footstalk of the superior antennæ. Anterior legs nearly of the same form as in the preceding species, but more enlarged, and having the pincers more irregular; those on one side slender and lengthened."

Alpheus dentipes. "Closely allied to the preceding: having likewise the supra-orbital vaults prolonged into points, but having the two anterior legs nearly of the same size; the pincers of the smaller large at the base, but becoming extremely narrow towards the end; having the third articulation of the second, third and fourth pairs of legs armed with a pointed tooth externally, at one-third the length of each."

Upon comparison of my Channel Island individual with the three species described above, I find the following points of agreement and difference between them.

It *assimilates* with *A. ruber* in having the larger hand furnished with longitudinal carinæ on the upper and the outer surface;

Differs, in *not* having the moveable finger shorter than the immoveable one; and *essentially* in the spinous armature to the supra-orbital hoods.

It *assimilates* with *A. Edwardsii* in having the anterior edge of the supra-orbital hoods armed with short spines; and in having the second joint of the superior antennæ half as long again as the first;

Differs, inasmuch as the lamellar appendage is *not* dilated towards the end; in the longitudinal carinæ upon the upper and outer surface of the larger pincers; in the proportions and form of the anterior feet, and in other minor particulars.

Assimilates with *A. dentipes*, as with *Edwardsii*, in the spinous terminations to the supra-orbital hoods;

Differs, with respect to the comparative proportion between the two anterior pairs of legs; and inasmuch as the three hinder pairs of legs are not armed externally with a pointed tooth.

Having thus shown in what respects the *Alpheus* from Herm assimilates with, and differs from, the three species above referred to, it remains to describe its own particular characteristics, which are as follows:—

The medial line of the carapace prolonged anteriorly into a short beak: *supra-orbital vaults*, each furnished at the extremity with a minute spine: *anterior legs unequal*; the *larger hand* having upon the upper edge two carinæ, one behind the other, each terminating anteriorly in a small tooth projecting forwards; two carinæ upon the outer surface of the claw, the lower one having a short tooth: the *moveable finger not* shorter than the immoveable one, flattened laterally, and broad at the point: the *immoveable finger* triangular, strong, and forming a kind of socket into which the opposing finger fits by a tubercle at its extremity: *lesser pincer* having a toothed keel upon its upper edge, equal in length to the others, but thinner, narrower, and much less robust: second pair of legs didactyle, slender, and having the wrist many-jointed.

Length 15 lines.

Colour deep scarlet, except the chelæ, which are mottled with yellow.

From the want of other works of reference, besides those of M. Edwards and of Professor Bell, I have it not in my power to ascertain whether the species now under notice has been distinguished by later carcinologists; but I have endeavoured, I think satisfactorily, to show that it cannot be identified with either of the European species of *Alpheus* described by the former distinguished naturalist. As regards both the figure and description of *Alpheus ruber* in Bell's 'British Crustacea,' they having been confessedly taken from an *imperfect* individual, found in the stomach of a Cod-fish, have so little in common with my Channel Island example, that, if identical with it, it must be presumed that all the more marked points of agreement between them had been digested away in the interior of the fish.

In the 8th volume of 'Loudon's Magazine of Natural History,' page 272, is however a notice of a Crustacean by the late Mr.

Hailstone, which certainly agrees far more nearly with my example than do either of those to which I have already referred ; so nearly indeed, that but little doubt remains upon my mind of its being identically the same. This species, which Mr. Hailstone calls "*Hippolyte rubra*," and of which a figure is annexed, is thus described :—

"Superior antennæ with two setæ, the upper ones fringed with hair and excavated below. Inferior antennæ nearly the length of the body. Pedipalps with three exerted joints, the last bluntly pointed, and twice the length of the preceding one, with two rows of fasciculi of hairs. First pair of legs didactyle, very large, with the hands much compressed, unequal, the right being the larger, bristly ; the thigh excavated beneath, and its inner margin spinulose ; second pair didactyle, very long, slender ; wrists many-jointed ; other legs terminated by a single claw and spinulose within ; the last pair the most slender. Thorax with three short spines anteriorly. Tail with five plates, the middle one blunt at its apex, with four spines arranged in two lines. Colour deep scarlet, except above the eyes, *which are concealed under the shell*, and above them it is transparent and colourless. The tail is fringed with white hairs, and the legs are mottled with yellow."

Upon this, at page 274 (same volume), is a note by Mr. Westwood, in which, with much skill and critical acumen, he traces Mr. Hailstone's individual to the group of *Alpheade*, and refers it to *Cryptophtalmus ruber* of Rafinesque, which M. Edwards identifies with his "*Alpheus ruber*." Mr. Westwood afterwards, at page 552, proposed to elevate it into the type of a new genus by the name of '*Dienecia*.'

Mr. Hailstone's description, as quoted above, might almost stand word for word as applicable to my example, with which it seems to tally in all important particulars, excepting as regards size, which, in the case of Mr. Hailstone's Crustacean, is barely two-thirds that of mine. The figures too attached to Mr. Hailstone's notice would serve equally well to illustrate mine, with the exception of the hairy fringe attached to the setaceous extremities of the superior antennæ.

If I am right in my supposition of the identity of my Channel Island Crustacean with the three individuals described by Mr. Hailstone as brought up by the trawl-net off Hastings in 1835, it is evident that the half-digested relics procured by Mr. Cocks at Falmouth are not the first examples of an *Alpheus* having been recorded as an inhabitant of the British seas. Indeed it is impossible to read Mr. Hailstone's careful and minute description without feeling convinced that a true *Alphean* was before him when he made his drawing and description ; and I may be par-

done for expressing my surprise, which I do with great deference to the high attainments of Professor Bell, that that distinguished naturalist, in adopting the "*Crangon bispinosus*" and "*trispinosus*" of Mr. Hailstone, should have omitted all reference to a form so very remarkable and so carefully detailed as Mr. Hailstone's "*Hippolyte rubra*."

In the belief that my Channel Island Crustacean is a new and undescribed species, I propose to bestow upon it the name of *Alpheus affinis*; thereby indicating the close relationship which it bears to the three other European species already referred to.

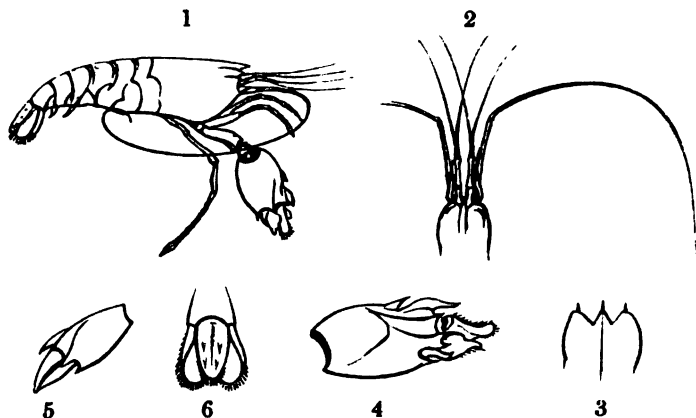


Fig. 1. *Alpheus affinis*, natural size.
 2. Enlarged view of front of carapace, showing supra-orbital vaults, insertion of antennæ, &c.
 3. Front of carapace still further enlarged, showing beaked rostrum and spinous armature of supra-orbital vaults.
 4. Enlarged view of larger pincer.
 5. Enlarged view of lesser pincer.
 6. Tail.

On Fossil Echinoderms from the Island of Malta; with Notes on the stratigraphical distribution of the Fossil Organisms in the Maltese beds. By THOMAS WRIGHT, M.D. &c., Professor of the Natural Sciences in the Cheltenham Grammar School.

READ 14TH SEPTEMBER 1854.

A. Notes on the Maltese beds, with the species they contain.

THE Island of Malta is entirely composed of tertiary rocks of Miocene age, which have been described by Capt. Spratt, R.N.*, and surveyed and mapped by the Earl Ducie†. Through his lordship's kindness, we have been enabled to study a complete suite of Maltese rock specimens, together with an extensive collection of the fossils obtained from them, whilst resident in the island; and it is but just that we should state, at the outset of these remarks, that whatever is valuable in this memoir relating to the stratigraphical distribution of the Urchins and other fossils in these beds, is entirely due to the Earl Ducie, who has most liberally given us all the information he noted on the spot, relative to the range and distribution of the species. It is to be distinctly understood, however, that neither the measurement of the beds, nor the limitation of the range of the fossils in them, are given as absolute truths, but rather as the nearest approximation thereto which the present state of our knowledge permits.

The Maltese islands comprise Malta, Gozo, and Cumino. Malta is seventeen miles in length by seven in breadth; Gozo is nine in length by five in breadth; and Cumino about two in length by one in breadth. The direction of their long axis is S.E. and N.W., which, with the channels, is about twenty-nine miles in length. All the rocks are sedimentary and marine, having a slight inclination from N.E. to E.N.E.; their direction corresponds with that of the Apennines, and with the intermediate

* "On the Geology of the Maltese Islands," with Notes on the Fossils by Prof. E. Forbes. Proceed. of the Geol. Soc. London, vol. iv. p. 225.

† The Earl Ducie kindly presented a copy of this map to Mr. Goodenough, book- and map-seller, Strada Reale, Malta, by whom it is now being published.

line observed in Sicily from the Val di Noto to Polizzi. Numerous faults traverse the N.W. half of Malta and the S.E. of Gozo, which have much disturbed the beds, caused the depressions now forming the north and south channels between Cumino and Malta and Cumino and Gozo, and left the islet of Cumino an isolated fragment of the uppermost beds, which attests the former continuity of the land, before these islands were fractured by subterranean and denuded by aqueous agency. "The mineral deposits," says Capt. Spratt, "composing this group, have a thickness of 800 feet visible above the sea; they lie nearly horizontal, and are conformable, although there is a great diversity of mineral character and condition in the series. None of the deposits are wholly destitute of organic remains; but, on the contrary, they generally contain them in tolerable abundance, and in a good state of preservation." The strata may be divided into five groups, each of which contains fossils that are special to it, very few of the species being common to the whole series. These, in a descending order, are, 1st, *the coralline limestone*; 2nd, *the yellow sand*; 3rd, *the clay*; 4th, *the calcareous sandstone*; 5th, *the hard cherty limestone*.

No. 1. *The coralline limestone*, consists of a reddish-white calcareous rock, mostly hard and compact, and sometimes changed into an indurated calcareous sandstone. It attains a thickness of 100 feet, but has been much denuded in several localities. Some isolated portions of this bed, from being slightly variegated in colour, were formerly used for certain durable work, under the name of Gozo marble.

Fossils of No. 1.

MOLLUSCA.

Voluta, cast of a large species.
Haliotis, ditto of a n. sp.
Trochus, ditto.
Spondylus quinquecostatus, *Desh.*
Ostrea Boblayei, *Desh.*
Ostrea Virleti, *Desh.*
Pecten Pandora, *Desh.*
 — *squamulosus*, *Desh.*
 — *Burdigalensis*, *Desh.*
Arca, casts of.
Cytherea, ditto.

BRYOZOA.

Eschara monilifera.
Escharina, n. sp.

CRUSTACEA.

Carapaces and chelæ of several species.

ECHINODERMATA.

Cidaris Miletensis, *Forbes*.
Echinus Duciei, *Wright*.
Echinolampas Deshayesii, *Desor.*
Clypeaster crassicostratus, var. of *C. altus*.
Brissus latus, *Wright*.
 — *imbricatus*, *Wright*.
 — *oblongus*, *Forbes*, *MSS.*
Brissopsis Duciei, *Wright*.
Schizaster eurynotus, *Agassiz*.
Pericosmus excentricus, *Wright*.

CORALLIA.

Stylastera.

No. 2. *The yellow sand*, is sometimes slightly indurated, and has an abundance of greenish-black grains intermixed with it. In some places it abounds with Foraminifera. Enormous numbers of *Lenticulites complanatus*, DeFr., the flat side of the shell corresponding with the bedding of the rock, occur in some localities, as in the cliffs of Ramala Bay, Gozo, and in many places in Malta. Intercalated with these Nummulites are banks of oysters, the teeth and vertebræ of fishes, especially those of the great shark, *Carcharodon megalodon*, with the bones of Cetacea. The greatest number of Echinoderms are likewise found in this bed. It varies in thickness from 10 to 40 feet.

Fossils of No. 2.

MAMMALIA, determined by
Prof. Owen (Forbes).
Delphinus, more than one species.
Manatus? bones apparently of this
genus.

FISHES, determined by Sir Philip
G. Egerton (Forbes).

Cerax aduncus, *Agass.*, teeth of.
Carcharodon megalodon, *Agass.*, do.
Carcharias productus, *Agass.*, do.
Oxyrhina xiphodon, *Agass.*, do.
— hastilis? *Agass.*, do.
— Mantelli? *Agass.*, do.
Hemipristis serra, *Agass.*, do.
— paucidens, *Agass.*
With other undetermined Squalidæ.

MOLLUSCA.

Nautilus, 2 sp., undescribed.
Scaloria retusa, *Brocchi*.
Voluta, Mitra, Cypræa, Conus, 2 sp.,
Columbella, Oliva, Natica, Turritella,
Turbo, Pleurotoma, Pyrula,
Phorus, Trochus;—casts only of
these genera.
Ostrea Virleti, *Desh.*

Ostrea navicularis, *Desh.*
Pecten cristatus, *Brown*.
— squamulosus, *Desh.*
— Burdigalensis and 3 other sp.
Arca, Isocardia, Venus, and Tellina,
in the form of casts.
Terebratula ampulla, *Brocchi*.
— bipartita.

BRYOZOA.

Cellepora mammillata.
Retepora.

ECHINODERMATA.

Clypeaster altus et var. C. turritus,
Leske.
— marginatus, *Lamk*.
— folium, *Agass.*
Echinolampas Richardi, *Desmoul.*
— Kleinii, *Goldf.*
Conoclypus plagiosomus, *Agass.*
Briassus oblongus, *Forbes*.

FORAMINIFERA.

Lenticulites complanatus, *DeFrance*.

CORALLIA.

Caryophyllia. Fungia.

No. 3. *The clay bed*, has a dark blue, drab, or a light gray colour, and is much charged with iron. In it are found crystals of gypsum, and occasionally nodules of sulphur. It varies in thickness from 30 to 60 feet. It is the retentive water-bearing stratum of the islands, and all the water falling upon the upper beds percolates through them, and bursts out in springs along their line of junction with the clay. Casts of shells and fragments of bones are very abundant in it; but Echinoderms are comparatively rare.

Fossils of No. 3.

FISHES.

Teeth of *Myliobatis*, *Lamna*, *Charias*, and *Euphyllia*, are abundant.

MOLLUSCA.

Megasiphonia zic-zac? (allied to the London-clay species).
Scalaria, *Pleurotoma*, *Mitra*, *Cassia*,
Rostellaria, *Conus*, 3 or 4 sp.,
Pecten, *Ostrea*, *Cardita*, *Lucina*.

ECHINODERMATA.

Spatangus Desmarestii, Goldf.
Pericosmus latus, Agass.

CORALLIA.

Fungia?

No. 4. *The calcareous sandstone*.—"This bed covers the greater part of the island of Malta. From it nearly all the building stone is procured, and it is likewise the rock from which the Maltese vases are cut. The lower beds abound in Echinoderms. *Scutella* and *Schizaster* are not unfrequent; but *Hemaster Scilla* is the most abundant species. These Urchins are often seen standing out in relief on the beach, the sea having worn away the surrounding rock. They are very serviceable in affording a foot-hold on the rocks, which otherwise would be dangerous to land upon." (*Lord Ducie*.) This bed is subdivided by Capt. Spratt into five strata, which he thus describes:—

"D. is a white calcareous sandstone, lying subjacent to the marl, into which it quickly passes, and is from 20 to 30 feet in thickness.

"E. is a bed of fine-grained sandstone, 15 to 20 feet thick, of a reddish-white, and sometimes gray colour. These contain several species of Foraminifera.

"F. a pale yellow calcareous sandstone, often containing flinty nodules, from 30 to 50 feet thick. In some parts it is thinly stratified, and separable into brittle plates of sandstone; but more generally it assumes a closely bound and unstratified character, when it is used for building; but it is very liable to exfoliate on exposure to the weather.

"G. Chocolate-coloured nodules, irregular in figure and size, in calcareous sandstone, with which are mixed casts of shells, *Caryophyllia*, and other organisms; also fishes' teeth, vertebræ, and coprolites are very abundant. All the nodules are of organic origin; it is, in fact, a bone-bed of considerable extent, for it preserves a very uniform character throughout the islands; but in Gozo it is more developed, and contains more remains; especially in a flat ledge just above the sea-level, under the cliffs of Fort Chambray, and at Marsa il Forno, on the north-east coast, where its durability has checked the encroachment of the sea. Its thickness is estimated at from 2 to 8 feet.

"H. A close-grained, pale yellow sandstone, incapable of being

split along the line of bedding. It is extensively quarried for building and other purposes, being easily cut with the knife or saw. Large blocks of it are turned into pillars, vases, balustrades, and other architectural ornaments. This stone is extensively used for building in the islands; and, for the same use, is largely exported to many parts along the shores of the Mediterranean. It attains a thickness of from 40 to 50 feet.

"The stone from which the finely-carved vases are cut, comes from the lower part of this bed, and is obtained near Naxiar. The rock in this locality dries whiter, is finer grained, and more compact than in general."—*Spratt*.

"It is impossible to distinguish between the beds D, E, F, in the above grouping, except in cliff-sections."—*Earl Ducie*.

Fossils of No. 4.

REPTILIA.

Chelonia, sp.

CIRRHIPODA.

Balanus stellaris.

Lepas, sp.

FISHES.

Pycnodus, numerous teeth of this genus, with vertebræ and other bones of this class.

CRUSTACEA.

Numerous remains of this class.

ECHINODERMATA.

Schizaster Parkinsonii, *DeFrance*.

— Desori, *Wright*.

Spatangus Hoffmanni, *Goldf*.

Scutella subrotunda, *Leske*.

— striatula, *Marcel de Serres*.

Brissopsis crescenticus, *Wright*.

Hemiaster Grateloupi, *Desor*.

— Scillæ, *Wright*.

— Cotteaui, *Wright*.

MOLLUSCA.

Nautilus, sp. undescribed.

Scalaria Duciei.

Conus, Cypræa, Solarium, Natica,

Phorus, casts only.

Pecten laticosta.

— Burdigalensis.

Lucina. Tellina.

No. 5. *The hard cherty limestone*, "is a yellowish-white cream-coloured limestone, having sometimes semi-crystalline strata alternating with an oolitic grit or sandstone, apparently composed of minute fragments of shells and corals. It attains a considerable thickness, since nearly 400 feet of it in perpendicular depth is visible on the north-west coast of Gozo." (*Spratt*.) "This bed forms a high and rocky coast-line on the south end of Malta, and dipping to the north appears about the water-line in the neighbourhood of Valetta and Sliema, forming a barrier to the sea. Probably the softer superincumbent beds have in course of time been worn away, till the appearance of this rock arrested any further encroachment. A *Scutella* invariably marks the junction of this bed with No. 4." (*Earl Ducie*.) The New Dock is built of this rock, and it is quarried in several places for building purposes, and it is likewise burned for lime.

Fossils of No. 5.

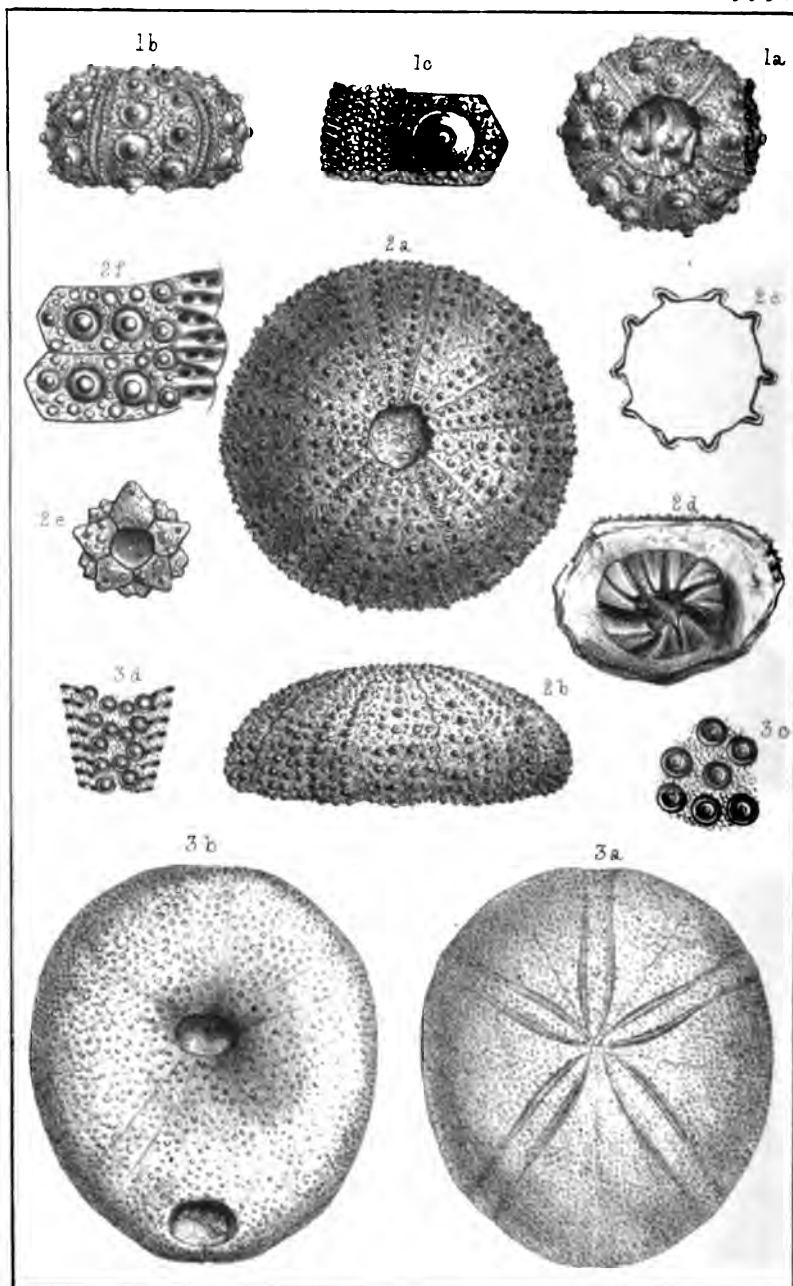
The fossils of this bed are imperfectly known, from being obtained with much difficulty. Of Mollusca, casts of *Solarium*, *Conus*, *Phorus*, *Natica*, *Cypræa*, *Pecten*, *Lucina*, and of the Cirrhipoda, *Balanus*, have been recognized in it. Of the Echinodermata, "*Scutella subrotunda*, *Clypeaster*, sp., *Brissus*, sp., identical with that of No. 2. Such is also the case with the *Pectens*." (*Forbes*.)

We cannot conclude our brief notice of these Maltese deposits without alluding to a similar Urchin bed of the same age in the island of Corsica. Through the kindness of our friend M. Michelin, the eminent zoophytologist of Paris, we received some time since a number of *Echinida* from this Corsican deposit, which we have carefully compared with the fine suite of Maltese Echinoderms now before us. Many of the species from Corsica and Malta are identical, although some from both islands are special to each region. From these data we conclude, that the deposits containing the Echinoderms described in the sequel of this memoir are of the Miocene period, and of the same age as the tertiaries of the south of France, the north of Italy, and of Doberg bei Bünde in Westphalia. M. Collomb, an eminent French geologist, lately visited the Urchin bed near Bonifacio in Corsica, and has given an account thereof in a letter addressed to Prof. Constant Prévost; the following abstract relating thereto will be read with interest:—

"We shall quit now," says M. Collomb, "the eruptive rocks, and transport ourselves to the south, at Bonifacio, where we have remained some days, to go and see the bed of fossil Urchins. They are found in a fragment of limestone completely enclosed in the granite. Bonifacio is built upon a high escarpment of this limestone, formed of horizontal beds having a coarse structure, full of the fragments of shells, the species of which were indeterminable. This escarpment is incessantly beaten and demolished by the action of the wind and the sea. Upon all this coast the beds overhang, and are worn into caverns by the inroads of the sea.

"The bed of Urchins is situated at some leagues to the north-east of Bonifacio, towards the roadstead of Santa-Manza, at the limit of the granite. The escarpment itself is here granitic, and the Urchin limestone caps the granite. The bed which contains the most beautiful specimens is only accessible by means of a ladder, and their extraction is difficult."

The Calcaire à Oursins is only found in three localities in Corsica, at Bonifacio, at Aleria, and at Saint-Florent, and



W. H. Barby del et lith

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1 a.-c. *Cidaritis Miletensis*.

2 a.-f. *Echinus Ducliei*,

3 a.-d. *Echinolampas Deshayesi*, Desor

Forbes digitized by Google

Wright

always in small detached beds of inconsiderable extent, which do not extend into the interior of the island. The deposits of Bonifacio and Saint-Florent were the only ones visited by M. Collomb*. The rock is a light-coloured limestone, sometimes white and soft, or hard and cherty, and contains an abundance of small quartz pebbles derived from the decomposed granite.

B. Description of the Fossil Maltese Echinoderms.

Cidaris Miletensis, Forbes MSS., n. sp. Pl. IV. fig. 1 a-c.

Test oblatly spheroidal, much depressed at both poles; ambulacral areas undulated, depressed in the centre, with an elevated marginal row of close-set tubercles on each side of the areas; poriferous avenues of the same width as the areas; interambulacral areas rather prominent, with two rows of primary tubercles, about six in each row; mammillary eminences large, each with a circle of boundary granules; spines nearly the diameter of the test in length, tapering from the base to the apex; mouth-opening very large.

Dimensions.—Height $\frac{8}{10}$ ths of an inch; transverse diameter $1\frac{2}{10}$ inch.

Description.—This is a very rare Urchin in the Maltese beds. It has an oblatly spheroidal figure, and is much depressed at both poles; the ambulacral areas, with the poriferous zones, are gently undulated; they measure together $\frac{8}{10}$ ths of an inch in width; the areal band is depressed in the middle, and its elevated margins are covered with two rows of large equal-sized close-set granules; internal to these are two rows of much smaller granules, and down the centre is a depressed furrow: the poriferous avenues lie likewise in depressions, bounded internally by the marginal granules of the ambulacral areas, and externally by the encircling granules of the primary tubercles: the interambulacral areas are $3\frac{1}{2}$ times the width of the ambulacral; they form rather prominent convex portions of the test, with from five to six rows of primary tubercles in each of the two rows of these areas: the areolas are large and prominent, the summits are smooth and without crenulations, and the tubercles, which are proportionately large, and with a very small perforation in their summit, stand well out from the body: a circle of larger granules surrounds the base of the mammillary eminences; these circlets are each complete in the two superior tubercles, but one series is common to two tubercles in those near the mouth; the boundary in all, however, is defined, as none of the

* Bull. de la Soc. Géol. de France, tom. xi. p. 67 et seq., 2 série.

areolar spaces are confluent: in the centre of the interambulacral areas is a depressed space, which is filled with small close-set granules: the mouth-opening is very large, and that for the apical disc is so likewise: the spines taper gently from the shoulder to their apex; they are round, and sculptured with longitudinal lines; their absolute length is not determinable, as neither of those before us are perfect; they may have attained the length of the diameter of the test.

Affinities and differences.—We know so few true *Cidarites* from the tertiary rocks, that materials for comparison fail us. The only species we possess is the *C. Alabamensis*, Morton, from the tertiaries of the U. States, which has nearly straight ambulacra, ten tubercles in each row in the interambulacra, with wide intertubercular spaces between each pair of rows. The Maltese Urchin differs essentially from this species, and may be easily distinguished from it by the concave ambulacral areas, and the marginal rows of tubercles that define these portions of the test. It is somewhat remarkable that we should have discovered so few *Cidarites* in all the Urchin beds that have been so diligently explored in the tertiary beds of Europe.

Locality and stratigraphical range.—This species has been found only in bed No. 1, the Gozo marble, where it is rare.

Echinus Duciei, Wright. Pl. IV. fig. 2 a-f.

Test circular, much depressed: ambulacral areas more than half the width of the interambulacral, with two rows of marginal, nearly equal-sized tubercles throughout, and two other rows within these, extending from the border to the mouth; one of these inner rows ascends a short way above the border: interambulacral areas with eight rows of tubercles at the border, diminishing to two rows above the others, disappearing or becoming of secondary size; from the border to the mouth, the eight rows continue of uniform size: the pores are in triple oblique pairs; between each pair there is a slight ridge of the test, which gives a singular zigzag figure to the poriferous avenues: mouth large and decagonal, base flat: apical disc of moderate size, but not preserved.

Dimensions.—Height $\frac{1}{2}\frac{5}{8}$ ths of an inch; transverse diameter $1\frac{1}{2}\frac{1}{6}$ inch.

Description.—This beautiful Urchin has been thought to be identical with the *E. Scilla*, Desmoul., and the one figured by Scilla in pl. 13. fig. 1, pl. 25. fig. 1, and pl. 26. fig. A, B, of his work*; but the number of tubercles on each of the plates

* De Corporibus Marinis Lapidescensibus.

in our specimen differs from the *Echinus* è *Messana* of that author, who has figured only one large tubercle on each plate of that form. From *E. Scilla* it is certainly distinct, as we know of no Urchin that is common to the cretaceous and tertiary rocks. The test is circular, much depressed on the upper surface and flat below; the ambulacral areas are almost $\frac{1}{10}$ ths of an inch in width at the border, where we count four rows of tubercles; the marginal rows are very uniform in size and arrangement from the mouth to the disc; the two internal rows are smaller, and continue from the border to the mouth; one of these extends a short distance on the sides, but on the upper half of the areas there are only the two marginal rows: the interambulacral areas are $\frac{1}{10}$ ths of an inch in width at the border; there are eight rows of tubercles at this point and onwards towards the base, they are nearly of the same size; but, from the border to the apical disc, the second row, from the ambulacral areas, alone possesses the size the tubercles have at the border; the tubercles in the others diminish in size, and disappear as the areas become narrower; above, we find only two marginal tubercles of the primary size, and internal to these, a few of secondary magnitude irregularly set: all the tubercles are raised on mammillary eminences, with areolas around their bases, and numerous large granules fill up all the intervening spaces, so that the surface of this *Echinus* has a very tuberculated appearance. The poriferous avenues are on a level with the test; the pores are arranged in triple oblique pairs; between each pair there is a slight elevated ridge; every two ridges of each triple oblique pair of holes is connected by another ridge, which runs at an angle of 45° to them; by this arrangement the poriferous avenues exhibit a curious zigzag character through these little elevations of the test in the line of the pedal pores. The base is flattened, the mouth-opening is large and decagonal, and the jaws and teeth are narrow and much curved inwards; the apical disc is absent in all the specimens we have examined; the space for the same is, however, of moderate size.

Affinities and differences.—This species may be distinguished from *Echinus Serresii*, Desmoul., from the Molasse de Provence, in having larger tubercles, with less granulation at their base, and the absence of the zigzag ridges between the pairs of pores: from *Echinus dubius*, Agass., another tertiary species from the Molasse of Villeneuve in Provence, it is distinguished by the more uniform size of its tubercles, the depression of the upper surface, and the zigzag ridges of the poriferous zones.

Locality and stratigraphical range.—It was collected from bed No. 1, the Gozo marble, Malta, where it is not uncommon. We

have dedicated this species to the Earl Ducie, who collected the beautiful specimens we have figured.

Family CLYPEASTRIDÆ.

This natural family includes all the Urchins which have a circular, elliptical, or pentagonal form, with a thick test, the surface of which is closely covered with small, nearly equal-sized tubercles sunken in the plates, and surrounded by ring-like areolas; these all carry short hair-like spines. The mouth is large, central and pentagonal, and is armed with five strong jaws which carry the same number of teeth: the anus is posterior, and marginal or inframarginal: the interior of the test is sometimes divided by pillar-like processes of the inner layer of the plates. The dorsal portions of the ambulacral areas have a petaloid form, circumscribed by large poriferous zones; the basal portions are narrow, rectilineal, or branched. The five genital plates form a circle around the madreporiform body, and between these are wedged the five ocular plates. This family includes the genera *Clypeaster*, Lamk., *Laganum*, Klein, *Echinarachnius*, Van Phels., *Arachnoides*, Klein, *Scutella*, Lamk., *Dendraster*, Agass., *Lobophora*, Agass., *Encope*, Agass., *Rotula*, Klein, *Mellita*, Klein, *Runa*, Agass., *Moulinia*, Agass., *Scutellina*, Agass., *Echinocyamus*, Van Phels., *Fibularia*, Lamk., *Lenita*, Desor.

Genus CLYPEASTER (Lamarck, 1816).

Form oval, inclining to pentagonal, rostrated before, truncated behind; upper surface more or less inflated, sometimes campanulate, conical or subconical; inferior surface flat, always concave around the mouth, with five straight simple ambulacral furrows proceeding from the angles of the mouth to the border; the dorsal portion of the ambulacral largely petaloid, greatly exceeding the interambulacra in size, and forming elegant leaf-like expansions, in general convex, arched, and prominent; bounded on each side by large poriferous zones, the pores of which are wide apart and united by transverse sulci; the apical disc formed of five genital plates at the summits of the interambulacra, with five ocular plates alternating with them; in the centre of this circle is the spongy madreporiform body, of a pentagonal figure: tubercles uniform in size and very numerous, equally distributed over the test; summits perforated, and surrounded by very deep areolas; mouth symmetrical, central, pentagonal, lodged in a concave depression in the middle of the base; auricles composed of ten distinct auricular processes set in pairs: the jaws form a pentagonal pyramid, composed of ten separate pieces, truncated at the summit, which is bordered by a subcircular band;

teeth five, large, and bent : anus small, round, and inframarginal : interior of the test with a number of pillar-like processes towards the border. All the species of this genus live in the seas of warm latitudes, or are found fossil in the tertiary rocks only. We have six living and twelve fossil species.

Clypeaster altus, Leske, sp.

SYN. *Echinus* à *Melita*, Scilla, Corp. Mar. pl. 9. figs. 1, 2.

Echinanthus altus, Leske, Klein, Echinoderm. apud Leske, No. 48. p. 189. pl. 53. fig. 4.

Echinus altus, Gmelin, Linné by Turton, vol. iv. p. 149.

Clypeaster altus, Lamarck, Hist. Nat. des Animaux sans Vertèbres, 2nd ed. tom. iii. p. 290 ; Deslongchamps, Encycl. t. ii. p. 199 ; Deffrance, Dict. Sc. Nat. t. ix. p. 449 ; Blainville, Man. d'Actin. p. 216 ; Desmoulins, Echinides, no. 7. p. 216 ; Agassiz and Desor, Cat. rais., Ann. Sc. Nat. tom. vii. p. 130 ; Sismonda, Ech. Foss. Nizza, p. 46 ; Ech. Foss. Piem. p. 40 ; Grateloup, Mem. Foss. Oursins de Dax, p. 41.

Test oblong ; anterior border convex ; lateral borders undulated ; posterior border squarely truncated ; marginal fold more or less thickened ; dorsal surface elevated into a dome shape ; vertex nearly central ; ambulacral areas largely petaloid, their base extending nearly to the margin : base flat ; mouth large and pentagonal, with a deep sulcus extending from the angles to the border, and corresponding to the middle suture of the ambulacral areas : anus small, round, and submarginal : granulations larger and more prominent at the base than on the dorsal surface.

Description.—This beautiful *Clypeaster* has been so long known, that it seems unnecessary to give any lengthy details of its structure ; although it may be remarked, however, that we are not aware that a detailed description of the species exists. It was first introduced to notice through the figure of Scilla, and the specimens before us belong to the same type as that given in his work. Many of the Maltese varieties of this species, however, are remarkable for their deviation from this typical form ; the dorsal surface in them rises into a campanulate shape, and the circumference becomes almost round. These varieties constitute the *Clypeaster turritus*, Agass., from the Miocene of Dax, and the *Clypeaster Agassizii*, Sismonda, from beds of the same age near Nice. We have before us a similar conical variety from Malta, belonging to the Museum of the Bristol Institution ; and others, collected by the Marchioness of Hastings, are in the Jermyn Street Museum.

All the specimens in Earl Ducie's cabinet, with one exception,

belong to what we regard as the typical form. This remarkable exceptional specimen agrees with the brief notice of *C. Tauricus**, Desor:—"Très grande espèce, allongée, pentagonale, à bord fortement renflé. Zones porifères très large à leur extrémité. Tert. du Taurus, île de Crète." If we are correct in referring all these varieties to *C. altus*, it follows that this species has a wide range of deviation from what we take to be its typical form; but these limits of variation are probably not greater in this than in some other species of Urchins. The following table shows the relative dimensions of three forms,—the typical, the conical, and the flattened and tumid varieties:—

Forms.	Length.	Breadth.	Height.
Type specimen	5 inches.	$4\frac{1}{8}$ inches.	$2\frac{1}{2}$ inches.
Conical, var. <i>a.</i>	$5\frac{1}{8}$ "	$5\frac{1}{8}$ "	$4\frac{1}{8}$ "
Tumid, var. <i>b.</i>	$6\frac{1}{8}$ "	$5\frac{1}{8}$ "	$2\frac{1}{8}$ "

The ambulacral areas are largely petaloid, nearly equal in length and width; they are rounded, widely open below, and extend over four-fifths of the dorsal surface in the type form, over nearly three-fourths in the conical form, and over almost four-fifths in the tumid varieties; in all, the areas form prominent convex elevations of the test, which are bounded by wide poriferous avenues, composed of two series of simple pores united by oblique grooves; the internal series of pores are round, the external series are elongated transversely in the direction of the grooves; the pores at the end of the avenues are much more so than those of the summit; the apical disc is small, and occupies the centre of the dorsal surface, lying in a slight depression formed by the bending-in of the summits of the areas; those of the single area, and the antero-lateral and postero-lateral areas of the left side, being rather more prominent than those of the right side of the test. The madreporiform body occupies the whole surface of the disc, the ocular and genital plates being quite indistinguishable from the general structure of the test; the five genital pores pass obliquely into the interior, at a short distance from the disc.

The base is flat, and the mouth lies in a very deep depression in the centre of the under surface; the opening is pentagonal, its wide walls being formed by the incurving of the basal portions of the areas; from each of the angles of the pentagonal opening, a deep furrow passes outwards towards the margin of the test, and becomes continuous with the median suture of the

* Cat. raisonné des Echinides, Ann. Sc. Nat. tom. vii. p. 131.

ambulacral areas. The jaws are absent in all the specimens we have examined. The anus is a small round aperture, situated near the posterior margin of the base of the test; in some specimens it is elongated in the transverse diameter, and measures about $\frac{6}{10}$ ths of an inch across. The tubercles are nearly of the same size on the upper surface, and their summits are level with the test, so that the areolas which surround them are excavated out of the superficial layer of the calcareous plates. The intertubercular surface is ornamented with a microscopic granulation, disposed in circles around the areolas of the tubercles, and filling up all the intervening spaces. The tubercles at the base are larger and more closely set together than those on the dorsal surface; a row of five or six tubercles is seen on each of the interfissural bands of the poriferous avenues.

Affinities and differences.—*C. altus* has many traits in common with *C. rosaceus*. In the general outline, in the size, form and extent of the ambulacral areas, there is much resemblance; but the campanulate form of the dorsal surface, the smallness of the apical disc, and the truncature of the posterior border constitute differences which may be traced through all the varieties *C. altus* assumes. The thickness of the marginal fold, and the great development of the ambulacral flower, when compared with the thinness of the border and the limited extent of the ambulacra, distinguish at a glance *C. altus* from *C. Tarbellianus*, *C. marginatus*, and *C. scutellatus*. The dome-shaped upper surface of *C. umbrella*, with its flattened ambulacral areas and convex prominent interambulacral spaces, its star-like apical disc and small mouth-opening, widely distinguish this species from *C. altus*. The affinity, however, is very near between *C. altus* and *C. crassicosatus*, the principal difference consisting in the more prominent rib-like prominence of the ambulacral areas.

Stratigraphical position.—This is the most abundant of all the Maltese Urchins. It is collected from bed No. 2, the yellow sand, associated with *C. Tarbellianus*, *Echinolampas Richardi*, and the other Echinoderms enumerated in the palæontological résumé given in the introduction to this memoir. The test is very well preserved in most specimens. Those from the sand with black particles are in the finest preservation. In this stratum the Urchins are accompanied with *Terebratula ampulla*, *Pecten squamulosus*, *P. Burdigalensis*, *Ostrea Virleti*, *O. navicularis*, and masses of *Lenticulites complanatus*, with *Cellepora mammillata*, *Escharina monilifera*, and other Bryozoa.

It has been collected from the Miocene beds of Port-de-Bouc, Saint-Miniato, Tuscany; Nice, Turin, Ile de Crète, Ile de Caprée; Bonifacio, Corsica; Oran. The Maltese specimens are

contained in the British Museum, Geological Museum, Jermyn Street, and Bristol Museum; that from the Ile de Caprée is in our cabinet.

History.—First figured by Scilla, in 1670. The list of synonyms prefixed to this article exhibits the various epochs in its history. In none of the works we have consulted is any detailed description of the species given.

Clypeaster marginatus, Lam.

SYN. Scilla, Corp. Mar. tab. 11. fig. inferior.

Clypeaster marginatus, Lam. An. sans Vert. tom. iii. p. 290, 2nd ed.; Deslongchamps, Encycl. Méthod. t. ii. p. 200; DeFrance, Dict. Sc. Nat. t. ix. p. 450; Blainville, Man. Act. p. 216; Grateloup, Foss. Ours. p. 40; Agassiz and Desor, Cat. raisonné, t. vii. p. 131; Desmoulins, Etudes des Echinides, no. 12. p. 218.

Test large, depressed, subpentagonal; margin thin, broad, and expanded; outline of the border undulated; ambulacral areas short, oval, and convex, rising abruptly from the thin border, and forming a dome-shaped elevation in the centre of the dorsal surface; base flat; mouth-opening small and pentagonal, with five simple sulci extending from the angles thereof to the margin; anus small, round, and submarginal.

Dimensions.—Antero-posterior diameter $6\frac{7}{10}$ inches, breadth $6\frac{1}{10}$ inches, height at the centre $1\frac{8}{10}$ inch, thickness of the margin about $\frac{1}{8}$ th of an inch.

Description.—This magnificent Urchin was figured by Scilla. The specimens before us agree very well with his drawing, although the foreshortening of the dorsal surface does not give a sufficient elevation to the ambulacral dome. The expansion of the margin, and thinness thereof, make a marked distinction between this and other cognate forms. The figures given by Grateloup of his *C. Tarbellianus* so exactly resemble the large specimen before us, belonging to the Bristol Museum, that we no longer doubt that species being a variety of *C. marginatus*. This species, like *C. altus*, exhibits much deviation from what may be considered to be its type form. A long and attentive study of the *Echinidae* has shown us, that such difference of outline is the rule, and not the exception, in the group; and that specific characters must be drawn from organic structure, and not merely from outline, if we wish our species to have a permanent place in the register of Nature's forms. The ambulacral areas are gracefully petaloid, rounded at the base and tapering towards the apex; they are convex and prominent, and extend about half-way between the vertex and the border, the test rising into a dome-shaped elevation in the region of the am-

bulacral areas. From the base of the areas to the circumference the margin is thin and expanded, and in this respect resembles a *Scutella* much more than a *Clypeaster*. The interambulacra between the poriferous avenues form convex elevations, which give a stellate character to the central dome, all the more conspicuous as it rises abruptly from the thin expanded margin, which is almost destitute of any elevation. The tubercles are larger on the basal than on the dorsal surface. In only one of the specimens before us is the inferior surface exposed. The base is flat. The pentagonal mouth is much smaller than in *C. altus*. In a specimen before us, measuring $4\frac{7}{10}$ inches in length, the mouth-opening is $\frac{7}{10}$ ths of an inch in diameter; the oral lobes curve inwards and form the interspaces thereof. Acute narrow ambulacral grooves pass outwards to the circumference.

Affinities and differences.—The thin and broadly expanded border of *C. marginatus*, with its short ambulacra, and central dome rising suddenly from the middle of the test, form a group of characters which enable us readily to distinguish this species from its congeners, with one exception, *C. Tarbellianus*. The excellent figures of this Urchin, given by Grateloup in his able Memoir*, we have compared with two forms of *C. marginatus* from Malta, and we confess our inability to distinguish the differences between them and the author's type-figure. Agassiz and Desor consider them to be the same, and we agree with their conclusion.

Grateloup observes, in describing *C. marginatus*, "We ought not to confound this species with that which I have described (*C. Tarbellianus*), with which it has great affinities of form, figure, and size. Its test has also a summit *très-renflé*, convex, and more elevated than in *C. Tarbellianus*; but its border is a little less *évasé*, and much less *tranchant*. The ambulacras are equally shorter, more *redressés*, and of a more oval and acute form." We have only to observe, that the characters here cited vary in different individuals, and at most amount to that limit of variation which we have already observed is seen in all species of Urchins, where a number of individuals of the same form are assembled for comparison.

Stratigraphical range.—This species is found in bed No. 2, the yellow sand, associated with *C. altus* and the other forms enumerated from that stratum; it has been found likewise in the Miocene beds of Touraine, Landes, Naros, Bonifacio, Santa Manza, Corsica; and Dax.

History.—First figured by Scilla, and afterwards by Leske. Fine specimens are contained in the Mus. Jermyn Street,

* Mém. sur les Ours. Foss. de Dax, p. 40. pl. 1. fig. 5-6.

British Museum, Bristol Museum, and the Collection of the Earl Ducie. The specimen in our cabinet is from Santa Manza, and was sent us by M. Michelin.

Clypeaster folium, Agassiz.

SYN. *Clypeaster folium*, Agassiz and Desor's Cat. rais., Ann. Sc. Nat. tom. vii. p. 131.

Test subheptagonal, much depressed; borders thin and sharp like *Scutella*; the petaloid ambulacra short, open, and expanded below; acutely lanceolate at the apex; ambulacral rosette small, and rising gently from the middle of the dorsum; poriferous zones lie in angular depressions; apical disc small, with a central prominent madreporiform tubercle.

Dimensions.—Antero-posterior diameter $1\frac{1}{2}$ inch, transverse diameter $1\frac{1}{2}$ inch, height $\frac{5}{10}$ ths of an inch.

Description.—The general outline of this little Urchin, with the structure of its ambulacral rosette, clearly prove it to be a *Clypeaster*, whilst its depressed dorsal surface and thin border show it to have affinities with *Scutella*. Its outline is subheptagonal, with the anterior border slightly produced; the petaloid ambulacral areas are short and widely expanded below, tapering and acutely lanceolate above; their apices closely approach at the vertex, and meet at the circumference of the madreporiform tubercle; the poriferous zones lie in angular depressions of the test, which, added to the convexity of the ambulacra, give a much greater relief to the petaloidal star than in other congeneric forms; the rosette formed by the petaloid portions of the ambulacra is small, being only a little more than one-half the diameter of the antero-posterior axis. The two rows of pores in the poriferous zones diverge gently from each other from the apex to the base, and there are from thirty to thirty-six pairs of holes in each zone. At the junction of the test-plates there are slight depressions on the surface, corresponding to the sutures between the same; the tubercles are small and set rather closely together, and the intervening granulation is quite microscopic; the border is exceedingly thin and entire; the base is concealed by firmly adherent matrix, which cannot be removed without fracturing the test.

Affinities and differences.—*C. folium* is allied to the young condition of *C. marginatus*, but the general flatness of the dorsal surface, and the absence of the campanulate elevation of the ambulacra in that species, added to the greater wideness of the basal opening of the petaloid ambulacral areas, and the more angular depression in the poriferous zones, afford points of comparison whereby these two species may be distinguished

from each other: the thinness of the border and flatness of the dorsal surface are diagnostic characters by which it may be known from its congeners.

Locality and stratigraphical position.—The only specimen we know from Malta is that contained in Earl Ducie's collection; it was obtained from bed No. 2. We have another specimen before us, kindly sent by M. Michelin from the Miocene terrain of Balistro, in the Gulf of Santa Manza, Corsica. Agassiz and Desor, on the authority of M. Deluc, give the tertiary of Palermo as the locality of their specimen.

History.—This species is enumerated in the 'Cat. rais.' of Agassiz and Desor, and stated to be "espèce très plate, à bords tranchant." A detailed description of this interesting form is now given for the first time.

Genus SCUTELLA (Lamarck, 1816).

Form in general suborbicular, extremely depressed, almost always discoidal, more or less enlarged behind; border often trenchant, disc entire, margin lobed; posterior border truncated; upper surface slightly convex; ambulacral flower small, with elegant, flat, blunt leaves; poriferous zones forming nearly a closed arch around them at their base; genital pores four, set around the spongy madreporiform body; base flat; mouth small, central, and pentagonal, with five ramose ambulacral furrows, sometimes branched, passing from the mouth to the border: tubercles microscopically small and very numerous; test thick, interior divided by pillar-like processes: auricles five; jaws forming a more or less elevated star composed of five distinct pieces, each formed by the organic union of two elements; teeth five, linear, and horizontal. This genus, as now limited, contains only fossil species, one of which is from the chalk of Georgia, United States; all the others are from the tertiary rocks.

Scutella subrotunda, Leske.

SYN. *Echinus Melitensis*, Scilla, De Corp. Marin. tab. 8. figs. 1-3.
Echinodiscus subrotundus, Leske apud Klein, tab. 47. fig. 7. p. 206.
Echinus subrotundus, Gmelin, Linné by Turton, vol. iv. p. 152.
Scutella subrotunda, Lamarck, Animaux sans Vert. 2nd ed. tom. iii. p. 284; Defrance, Dict. Sc. Nat. tom. xlviii. p. 230; Desmoulins, Etudes des Echinides, no. 24. p. 232; Grateloup, Ours. Foss. pl. 1. fig. 1. p. 36; Agassiz and Desor's Cat. rais., Ann. Sc. Nat. tom. vii. p. 132.

Test very flat, suborbicular; dorsal surface slightly convex; ambulacral areas exceeding in length the semi-diameter of the

disc; base slightly concave; mouth central; anus marginal; ambulacral sulci bifid and branched.

Dimensions.—Antero-posterior diameter $2\frac{8}{10}$ inches, transverse diameter $3\frac{2}{10}$ inches, height $\frac{7}{10}$ ths of an inch.

Description.—The test of this delicate Urchin is extremely flat; it has an irregular suborbicular discoidal form, with a thin sinuous margin; the dorsal surface is regularly and gently convex. The ambulacral areas are more than half the length of the diameter of the test; they are of an oblong form, lanceolate above, and more obtuse below. The pores in the avenues are widely apart; those in the inner series are round, whilst those in the external series terminate in slits that extend about half way across the interporiferous spaces. The apical disc is large, and the elements thereof are intimately soldered together. The madreporiform tubercle occupies the centre, and the four genital pores are pierced at unequal distances around it; the anterior pair are smaller and closer together than the posterior pair; the five ocular pores are very small. The margin of the disc is very thin, and has a sinuous outline; five of the curves thereof correspond to the ambulacral areas, and those appertaining to the postero-lateral areas are the deepest and best defined; a small notch indicates the site of the anal opening. The ventral surface is slightly concave. The mouth, about two lines in diameter, is central and subpentagonal; from the angles thereof, five ambulacral sulci radiate outwards, which soon become bifid, each trunk becoming dichotomously branched in old individuals. The anal opening is round, about half the diameter of the mouth, and is situate near the posterior border. The tubercles are small, and closely placed together; they are nearly of a uniform size on the dorsal surface.

Affinities and differences.—*S. subrotunda* so closely resembles *S. striatula*, *S. Faujasii*, and *S. producta*, that it requires an attentive study to discover the differences between them. As we possess single specimens only of these forms, determined and presented to us by M. Michelin of Paris, we are certain of their identity with the types they represent. The test is narrower before, and the ambulacral areas are much smaller in *S. striatula* than in *S. subrotunda*; the ambulacral areas are wider, their bases and apices are more obtuse, their sides flatter, and their terminations are more truncated, and the anus further from the border in *S. producta* than in *S. subrotunda*; the test is more convex on the dorsal surface, the apical disc is wider, the margin is thicker, the base flatter, and the anal aperture much further from the border in *S. Faujasii* than in *S. subrotunda*; the test is more produced posteriorly, the margin is more sinuous, the ambulacral

areas are more equally lanceolate at the base and apex, the inner row of pores of the same curve more gracefully outwards, and the anus is further from the border in *S. Brongniartii* than in *S. subrotunda*. The size and pyriform shape of the ambulacral areas, the absence of sinuosities in the margin, and the greater convexity of the dorsal surface, distinguish *S. Paulensis* from *S. subrotunda*.

Stratigraphical range and distribution.—This species is not uncommon in the calcareous sandstone bed No. 4, and in the junction beds of No. 5, the hard cherty limestone, at Malta. It is found likewise "in the marine calcaire grossier in the environs of Bordeaux; at Bazas, Léognan, Gradignan, Douai, in Dauphiné; in Tourraine; in Anjou; at Montpellier." (*Grateloup*.)

History.—The table of synonyms shows the phasis of the history of this species, although other forms have been mistaken for it: in fact, the species of *Scutella* approach each other so closely, that, without an authentic series of specimens for comparison, similar mistakes may be made. This Urchin is found in all the public collections. The specimens before us are from Malta and Léognan.

Scutella striatula, Marcel de Serres.

SYN. *Scutella striatula*, Marcel de Serres, Géognosie des Terrains Tertiaires, p. 156; Desmoulins, Etudes des Echinides, no. 25. p. 234; Agassiz, Monogr. des Scutelles, tab. 18. fig. 1-5. p. 81; Agassiz and Desor's Cat. raison., Ann. Sc. Nat. tom. vii. p. 134. *Scutella subrotunda*, Grateloup, Mém. Ours. Foss. tab. 1. fig. 1. p. 36.

Test very flat, suborbicular; dorsal surface very slightly convex; ambulacral areas small, short and narrow, less than the semi-diameter of the disc; base nearly flat; mouth central; anus marginal; ambulacral sulci bifid.

Dimensions.—Antero-posterior diameter $2\frac{7}{10}$ inches, transverse diameter $2\frac{2}{10}$ inches, height $\frac{7}{10}$ ths of an inch.

Description.—This Urchin so nearly resembles *S. subrotunda*, that it may be doubted whether it is entitled to rank as a distinct species, or ought rather to be considered as a variety of that form. The two specimens before us are from localities widely apart from each other. One is from the Miocene terrains of Terre-Nègre, near Bordeaux, the other from the calcareous sandstone of Malta. Still the similarity exhibited by these specimens, and the persistence of those characters which have been considered as specific, incline us to think that *S. striatula* may be distinct from *S. subrotunda*. The ambulacral rosette is small; the areas are short, narrow and lanceolate, and are less than the semi-diameter of the test; the apical disc is small; the madreporiform

tubercle is prominent and central; the granulations are almost microscopic; the base is flat; the mouth is small and central, and the anus marginal; the ambulacral sulci are bifid; the margin of the test is thin, and the sinuosities well marked. Let the student compare these characters with the detailed description of *S. subrotunda* given in the preceding article.

Locality and stratigraphical range.—It was collected from bed No. 4, the calcareous sandstone at Malta, where it is not common. Our French specimen is from the middle tertiaries of Terre-Nègre.

Genus ECHINOLAMPAS (Gray, 1835).

Test of an elongated or subdiscoidal form; petaloid portion of the ambulacral areas large, generally elevated into convex leaves, contracted towards the base, where they cease to rise above the level of the test; inferior surface concave towards the mouth, which is median, symmetrical, pentagonal, and surrounded by five lobes; basal portions of the ambulacra with five short poriferous zones around the mouth; anus transversely oblong and inframarginal; apical disc small and excentral, five genital and five ocular plates placed around the madreporiform body; tubercles small, uniform and numerous, sunk in the test, and surrounded by ring-like areolas. Three species are living in the seas of warm latitudes; the others are fossil, mostly in the tertiary rocks. A few are found in the upper stages of the cretaceous series.

Echinolampas Kleinii, Goldf.

SYN. *Clypeaster Kleinii*, Goldfuss, Petrefact. Germaniæ, tab. 42. fig. 5. p. 133.

Echinolampas Kleinii, Desmoulins, Etudes des Echinides, p. 346. no. 14; Agassiz and Desor, Cat. raisonné, Ann. Sc. Nat. tom. vii. p. 166.

Test ovato-orbicular in the outline, with the posterior border slightly produced; dorsal surface convex, posterior half more elevated than the anterior; ambulacral areas unequal, usually on a level with the general surface, but sometimes more convex and prominent than the rest of the test; apical disc excentral and anterior; base concave; mouth excentral and anterior; anus inframarginal; both mouth and anus transversely oblong.

Dimensions.—Antero-posterior diameter $2\frac{9}{10}$ inches, transverse diameter $2\frac{1}{2}$ inches, height $1\frac{9}{10}$ inch.

Description.—This Urchin has been well figured by Goldfuss, and is a very characteristic fossil of the Miocene tertiary beds

of Westphalia, where it appears to be common. The specimen before us is the only one we know from Malta. The circumference is nearly ovato-orbicular, slightly inclining to an obsolete pentagon, with the posterior border most produced. The dorsal surface is highly convex, the posterior half being much more so than the anterior. The ambulacral areas are unequal, as regards length, width and development; the single anterior area is the shortest and narrowest, the antero-laterals are next in size, and the postero-laterals are the most fully developed; they have all a lanceolate form, with blunt apices. The surface of the areas is on a level with that of the interambulacra, in the specimen before us; but in some of the Westphalian Urchins the ambulacral areas form convex projections on the surface of the test. The poriferous avenues, extending down more than two-thirds of the dorsal surface, are well marked in our specimen, and lie in depressions of the test; they consist of two series of pores; the internal holes are round, the external run into oblique slits that have a direction upwards and inwards; the pores on the right and left sides of the areas do not always correspond in length; thus, the anterior pores in the antero-lateral areas are often only half as long as those on the posterior side of the same areas, and we see a similar inequality, although not to the same extent, in those of the single ambulacrum. The anterior and posterior pair of the interambulacral areas are much alike in form and development; but the single interambulacrum is different, it forms a more convex eminence than the others above, and is produced into a slight caudal appendage behind. The apical disc is small and excentral, situated nearer the anterior border. The madreporiform body occupies the centre, around which the four genital holes are pierced. The base is concave; the mouth is nearer the anterior border, is transversely oblong, and surrounded by five lobes, formed by the termination of the interambulacra; the posterior single lobe is the largest; the anterior pair are next it in size, and the lobes of the postero-lateral areas are the smallest and most contracted. Between the five oral lobes, the poriferous terminations of the ambulacral areas form petaloidal depressions, which are perforated with numerous holes; these run out and form lines which indicate the basal boundaries of the areas. The anus is transversely oval, $\frac{1}{10}$ ths of an inch in its long diameter, is more convex on its anterior than its posterior border, and is situated close to the margin; it is rather larger than the mouth-opening. The tubercles are small, uniform in size, and closely set together on the dorsal surface, and longer and more widely apart on the base.

Affinities and differences.—The great convexity of the dorsal

surface, the greater elevation of the posterior than the anterior half thereof, the inflated ridge-like eminence formed by the single interambulacrum, and the well-defined character of the poriferous avenues, form a group of characters by which *E. Kleinii* is distinguished from its congeners. It has many points of resemblance in common with *E. ovalis*; but the greater length of the ambulacral areas in this species makes a marked distinction between them; moreover, in *E. Kleinii* the base is concave, whilst in *E. ovalis* it is convex; the latter form is likewise flatter and more oval, and its apical disc more excentral than in *E. Kleinii*.

Stratigraphical position.—Collected at Malta, from bed No. 2, where it is very rare. It is found, according to Goldfuss, in the Miocene beds at Bünde, Osnabruck, Astrapp, and Merminghüfen, in Westphalia.

History.—Admirably figured and well described by Goldfuss. The only Maltese specimen we have seen of this species is that collected by the Earl Ducie, which is in his lordship's museum.

Echinolampas Deshayesii, Desor, sp. Pl. IV. fig. 3 *a-d*.

SYN. *Echinolampas Hayesiana*, Agassiz and Desor, Cat. raisonné, Ann. Sc. Nat. tom. vii. p. 166.

Test oval, depressed; ambulacral areas narrow; the poriferous zones contracted, without apparent connecting transverse sulci; apical disc small and nearly central; base convex; mouth and anus large.

Dimensions.—Antero-posterior diameter $2\frac{1}{10}$ inches, transverse diameter $1\frac{2}{10}$ inch, height $\frac{3}{10}$ ths of an inch.

Description.—The form, size and structure of the ambulacral areas afford the best guide to a knowledge of the numerous species of this group. The Urchin before us has an oblong form, depressed at the dorsal surface, convex at the base, and slightly produced posteriorly. The ambulacral areas are narrow at their widest part; they are about one-sixth the width of the postero-lateral interambulacra at the border. The poriferous zones are narrow, and extend rather more than half-way down the dorsal surface; the pairs of pores are placed closely together, and the slit or sulcus, which in general unites the inner and outer series of pores together, is absent in this species, or at all events is not apparent in the individuals before us; the holes of both rows are nearly of the same size. The interambulacral areas are wide; the antero-lateral are the narrowest; the single interambulacrum is slightly produced in the region of the anal opening. The apical disc is small, and situated near the centre of the test,

rather nearer the anterior than the posterior border. The disc consists of a central madreporiform spongy body, around which the genital and ocular plates are arranged in a circle; their sutural lines of union, however, are concealed, and can only be seen in weathered specimens. The base is convex; the mouth is very large, and lies in a deep depression opposite the vertex; it is surrounded with five oral lobes of small size, with intervening petaloidal depressions, perforated with holes in pairs. The interambulacrum is slightly produced posteriorly. The anus is a large transversely oblong opening, situated near the margin. The border of the test is rather obtuse. The tubercles are of uniform size on the dorsum, and are larger and less numerous than in *E. Kleinii*.

Affinities and differences.—This species resembles much *E. scutiformis*, but is distinguished from it by the greater narrowness of the ambulacral areas, and the absence of the transverse slits or sulci by which the pairs of pores in these avenues are in general united. The tubercles are more abundant on the dorsal surface in *E. Deshayesii*, and the dorsal surface is not so much elevated in that species as it is in *E. scutiformis*.

Locality and stratigraphical range.—This species was collected from bed No. 2, the yellow sand, at Malta. Desor gives the "Tert. moyen. d'Oran (Algérie) et de Carthagène (Catalogue)" as his localities; and we have received from M. Michelin of Paris a specimen from the Miocene terrain of Balistro, Corsica, which has enabled us to identify the Maltese Urchin, and make out the preceding description, the first given of this pretty form.

Echinolampas Richardi, Desmarest.

SYN. *Scutum ovatum Issyaviense*, Klein, Echinodermatum, tab. 20. fig. a, b, § 77. p. 29 (?).

Clypeaster Richardi, Desm. Dict. Sc. Nat. t. liv. tab. 5. p. 12, spec. ined. in litt.; Grateloup, Mem. Echin. Foss. tab. 1. fig. 8 a, b, p. 44.

Echinolampas Richardi, Desmoulins, Etudes sur les Echinides, p. 342. no. 4.

Echinolampas Laurillardi, Agassiz and Desor, Ann. Sc. Nat. t. vii. p. 165.—Scilla, Corp. Mar. tab. 11, top figure, showing the base only.

Test oblong, produced posteriorly, rounded before, flattened laterally, caudate posteriorly; dorsal surface convex, elevated; base concave; mouth central; anus inframarginal, lodged in a caudal process of the interambulacrum; ambulacral areas narrow, with contracted poriferous zones.

Dimensions.—Antero-posterior diameter $1\frac{7}{10}$ inch, transverse diameter $1\frac{2}{10}$ inch, height $\frac{1}{4}\frac{7}{10}$ ths of an inch.

Description.—The specimen before us is so much injured on the dorsal surface, that we are unable to give a detailed description of this species, which appears to be not uncommon at Malta. The ambulacral areas are narrow; the pores lie in contracted zones, and the pairs are unconnected by sulci; the avenues extend more than half-way down the sides of the test; the dorsal surface is elevated and convex, rounded before, and sloping gradually from the vertex to the posterior border; the apical disc is very excentric, and placed near the anterior border; the circumference of the test is of an irregular oblong figure, round before, flattened on the sides, and produced behind: the base is undulated by the elevations of the interambulacra and the depressions of the ambulacral areas; the single interambulacrum is prolonged backwards, and is truncated at the sides and at the posterior border, which gives it a caudate form. The mouth is nearly central, and is sunk in a deep depression; it is transversely oblong, and is surrounded by five oral lobes, having five petaloidal depressions of the ambulacral areas, with three pairs of pores in each petal between them; the anus is larger than the mouth-opening, and is situated at the inframarginal border of the caudate process of the interambulacrum; it has a transversely oblong form, and is more convex before than behind. The Urchin figured by Grateloup is much larger than the Maltese specimens that have come under our notice; but the central mouth-opening and the form of the interambulacrum induce us to think that it is only a gigantic variety of *E. Richardi*, and not *E. Kleinii*, as supposed by Desmoulins. The identity of this species with Klein's *Scutum ovatum Issyaviense* may or may not be correct, as the figures of fossils in that work are not in every case to be depended on.

Affinities and differences.—*E. Richardi* has some resemblance to *E. Kleinii*, but the narrow ambulacral areas, the flattened sides, and produced caudate interambulacrum in *E. Richardi* afford points of distinction by which these allied forms may be readily distinguished from each other. In *E. Kleinii* the base is more concave, the mouth nearer the anterior border, and with larger oral lobes than in *E. Richardi*. The dorsal surface presents other points of difference: in *E. Kleinii* the posterior half of the test is the most elevated, whilst in *E. Richardi* it slopes rather abruptly downwards from the vertex to the truncated posterior border.

Locality and stratigraphical range.—It was collected from bed No. 2, at Malta; the specimen before us is the only one in Earl Ducie's cabinet. The Geological Museum in Jermyn Street possesses an interesting series of this form, which are all from the same island. Grateloup found the large variety at Dax, in

the "faluns bleus de Narrosse," and adds that it is found likewise at Paris, Montpellier?, Bordeaux, and the Vicentin: Desmoulins adds St. Paul-trois-Châteaux (Drome) as another locality.

Genus CONOCLYPUS (Agassiz, 1839).

Test thick, hemispherical or oval, and always much elevated; ambulacral areas above long, wide, converging at the summit, a little contracted below; mouth median, symmetrical, pentagonal, and surrounded by five large lobes; base flat, basal portion of the ambulacra with poriferous zones around the mouth-opening; anus inframarginal, sometimes transversely oblong. The species are all fossil, and belong mostly to the tertiary rocks: one is found in the Maestricht chalk. This genus is nearly allied to *Echinolampas*. The character upon which M. Agassiz relied as diagnostic between *Conoclypus* and that genus, the direction of the anus, which is stated* to be elongated in the antero-posterior diameter in *Conoclypus*, and in the transverse diameter in *Echinolampas*, does not hold good in all the species.

Conoclypus plagiosomus, Agassiz.

SYN. *Conoclypus plagiosomus*, Agassiz and Desor, Cat. rais., Ann. Sc. Nat. 3rd series, tom. vii. p. 168.

Test thick, large, highly convex; border acute; outline round, inclining to oblong, being slightly compressed on the sides; ambulacral areas narrow, even with the interambulacra; poriferous zones very narrow; the inner and outer pores nearly equal in size, and extending through three-fourths of the areas; base concave; mouth nearly central, with large oral lobes; anus large, transversely oblong and inframarginal.

Dimensions.—Antero-posterior diameter 6 inches, transverse diameter $5\frac{8}{10}$ inches, height 8 inches.

Description.—This noble Urchin has been mistaken for *C. conoideus*, Lamk., as in form, size, and some of its general characters it resembles that type species; but the eye of the practised zoophytologist detects, in the structure and narrowness of the poriferous zones, an organic character sufficient to enable him to separate it from that species. The general outline of the base is round, inclining to oval from the gentle compression of the sides thereof; the dorsal surface is much elevated and highly convex, and the vertex is situated in front of the centre of the dome; the ambulacral areas are nearly one-fourth the width of the interambulacral areas at the border, and are level with them; they are nearly of a uniform width throughout, becoming lan-

* Ann. Sc. Nat. tom. vii. p. 167.

ceolate at their upper fifth: the poriferous avenues are very narrow, and extend three-fourths of the distance between the apex and the border: the pores in the avenues are only about one line apart, and are united by short slits directed obliquely upwards and inwards at nearly equal spaces apart from the base to the apex; the pores in the outer and inner series in each zone are about the same size throughout: the narrowness of the poriferous avenues forms a very important character in this species, by which it is distinguished from an allied form, *C. conoideus*. The interambulacra are of a triangular form; the antero-lateral are the smallest, and the postero-lateral and single interambulacrum of about the same size are the largest: the apical disc is small, and situated nearer the anterior than the posterior border, which occasions a slight difference between the angle of inclination of the anterior and posterior sides of the test: the centre of the disc is occupied by a prominent button-like spongy madreporiform body, around which the genital and ocular plates are arranged, but their lines of suture can only be distinguished in weathered specimens, or by removing the superficial layer of the plates. The entire surface of both areas is covered with tubercles, very much alike both as regards size, form, and irregularity of arrangement; the only parts exempt from tubercles are the interporiferous septas of the avenues: the base is concave: the mouth is situated in the centre of the disc, and is surrounded by five large prominent lobes: the ambulacra form petaloid depressions between the oral lobes, in which a number of pores are clustered together in pairs. The anus is a large, transversely oblong opening, placed immediately beneath the posterior margin; from it to the mouth an elevated ridge of the test runs: the single interambulacrum is slightly produced posteriorly where the anus terminates: the tubercles are larger, and placed at greater intervals apart on the base than on the dorsal surface: the marginal fold of the test forms an acute angle, and on the border thereof the tubercles are clustered closer together in greater numbers, with smaller interspaces between them, than in any other part of the skeleton.

Affinities and differences.—This species very much resembles in form and size *C. conoideus*, but it is readily distinguished from it by the following characters: the ambulacral areas are smaller, the poriferous zones are narrower, and the outer and inner pores of each pair are nearly of the same size, whilst the septas between the pores are thicker; the dorsal surface is not so much elevated, the base is concave, the anus is large and transversely oblong, and the mouth possesses very prominent oral lobes.

Locality and stratigraphical range.—This Urchin was collected at Malta, from bed No. 2. The fine specimen before us belongs

to the Bristol Institution ; we possess one, through the kindness of M. Michelin, from the celebrated Urchin bed of Balistro (Corsica) ; it is found likewise in the "Molasse du Cap Couronne près Martigues." (*Michelin.*)

Family SPATANGIDÆ.

The general outline of the Urchins of this family is oval, oblong or cordiform, and they satisfactorily exhibit the bilateral symmetry of the *Echinidæ*. The mouth is anterior, bilabiate, and edentulous. The anal opening is posterior and supramarginal, and is closed by a complicated series of small plates. The apices of the ambulacral areas are united at the summit of the test. The anterior single ambulacrum has a different structure from the antero- and postero-lateral pairs, and is in general lodged in a depression of the test, which extends to the anterior border forming the anteal sulcus ; the test is extremely thin, and is covered with small tubercles which support hair-like spines ; besides these there are some larger crenulated and perforated tubercles which support large spines. There are two or four genital pores which are sometimes placed close together, but are in other genera apart. The eye-plates are five in number, and are placed at the apices of the ambulacra in a pentagonal form around the genital plates. We observe on the surface of the test of some *Spatangidæ*, certain delicate lines called *fascioles*, having a smoother appearance than the tubercular surface of the test ; they are furrows which are strewn with microscopic tubercles destined to carry very delicate spines, which, when seen under the microscope, appear to have the same structure as the *Pedicellariæ*. The fascioles have a different disposition in each genus, and afford a good character in giving definitions of the same ; when the fasciole surrounds the ambulacral petals like an undulating groove, as in *Hemiaster*, *Schizaster*, &c., it is said to be a *peripetal* ; when it surrounds the single ambulacrum, as in *Amphidetes*, it is *internal* ; when it extends along the sides, as in *Schizaster*, it is *lateral* ; when it surrounds the circumference of the test, as in *Pericostmus*, it is *marginal* ; when it is limited to the base of the anal opening, it is *subanal*. We find sometimes in the same genus more fascioles than one ; thus the subanal and peripetal are frequently associated together.

Genus SPATANGUS (Klein, 1734).

Urchins, in general large with a thin test, a convex dorsal surface, and the antero-lateral and postero-lateral ambulacral areas composed of larger petals than in other *Spatangidæ*. The ante-

rior ambulacrum is lodged in a deep anteal sulcus; the upper part of the anterior border of the antero-laterals is obliterated towards the summit.

Numerous very large crenulated and perforated tubercles are scattered over the surface of the ambulacral plates. They have a deeply grooved subanal fasciole; only four genital pores, the anterior pair more closely approached than the posterior pair.

Five perforated ocular plates, arranged in the form of a pentagon, around the genital pores. A tube or hollow cone at the internal part of the single interambulacrum. A large vertical plate passing into a cone arises from the internal surface of the test upon the left side of the mouth, and is directed obliquely upwards and backwards.

The species are living or fossil in the tertiary rocks.

Spatangus Hoffmanni, Goldfuss.

SYN. *Spatangus Hoffmanni*, Goldf. Petrefacta, Band i. p. 152. tab. 47. fig. 3 a, b, c; Desmoulins, Etudes sur les Echinides, p. 398. no. 35; Grateloup, Mém. Echinid. Foss. tab. 1. fig. 8. p. 73; Agassiz and Desor, Ann. Sc. Nat. tom. viii. p. 7.

Echinus (petrefactus), Scilla, Corp. Mar. pl. 10. fig. 1.

Test convex, depressed anteriorly, elevated and carinated posteriorly; antero-lateral and postero-lateral interambulacra with numerous large, perforated and crenulated tubercles, surrounded by deep sunken areolas; base convex, the postero-lateral areas with large tubercles; interambulacrum forming a tumid projection at the base; mouth and anus large; marginal fold acute; the pores in the zones large, disposed in wide-set pairs.

Dimensions. — Antero-posterior diameter $2\frac{2}{10}$ inches, transverse diameter 2 inches; height anteriorly $\frac{7}{10}$ ths of an inch, height posteriorly $\frac{1}{2}$ ths of an inch.

Description. — The characters of this form of *Spatangus* are so prominent and well defined, that one is astonished that between the time of Scilla, who first figured it, and that of Goldfuss, who first described it, no zoophytologist should have become its historian. The dorsal surface of the test is broad, convex, and depressed anteriorly, and narrow, elevated, and carinated posteriorly; the ambulacral areas are well defined, the single ambulacrum with its rudimentary pores is lodged in a wide but shallow anteal sulcus, and there is a flattened plateau between the sulcus and the apical disc; in this region the obsolete pores are clearly seen: the antero-lateral ambulacral areas extend outwards at an angle of 24° from a transverse line drawn through the apical

disc*: the posterior poriferous zone extends two-thirds of the distance between the disc and the border; the anterior zone commences much farther from the disc above, but extends as far as the posterior zone below; thus in the specimen before us, there are fourteen pairs of pores in the posterior, and only nine in the anterior zone: the postero-lateral ambulacral areas extend backwards, and towards their termination they curve gracefully outwards; the angle they form at the transverse line at the disc is 62° , and there are twenty pairs of pores in each of the zones. Each of the interambulacral areas presents peculiar characters; the antero-lateral pair are the smallest, and the postero-lateral are the largest; they are both remarkable for the tubercles they support on their dorsal surface; in the anterior pair there are nine, and in the posterior pair there are fourteen of these tubercles on each side of the test, which are sculptured out of the substance of the plates; as they do not project beyond the general surface of the shell, each tubercle is seated on a cylinder, which is surrounded by a deep, wide depression: as these perforations are not arranged with much regularity, the test has the appearance of having been bored by some marine mollusk. The tubercles themselves, in proportion to the size of the supporting cylinder and encircling entrenchment, are small and perforated; the single interambulacrum is narrow and elongated, and rises in the mesial line into a prominent elevated ridge; the posterior border is obliquely truncated downwards and inwards, in the upper part of this space the large anal opening is situated; below, the interambulacrum forms another prominence marked by two concave depressions on each side thereof, from which a wide, gently sloping central space occupies the middle of the ventral surface, having the large transversely-oblong mouth-opening with its projecting posterior lip occupying the anterior third of the base; on the sides of this sloping central space the basal portions of the postero-lateral interambulacra are thickly studded with large slanting perforated tubercles, arranged with much regularity in this region, and a few smaller tubercles are scattered over the basal portion of the antero-lateral pair; the crescentic depressions below the anus have each a group of perforated tubercles, and between them and the smooth central concave portion of the base is the subanal fasciole, which forms a transverse band in the middle, and a crescent on each side, the upper

* It may be as well to state, that we have adopted this mode of measuring the amount of divergence of the antero-lateral and postero-lateral areas rather than the vague expressions formerly in use. The angle is measured from a transverse line which cuts the longitudinal axis at right angles at the apical disc; we have found the degree of divergence to be very uniform in each species.

cornua of which approaches the anal opening ; below the fasciole there is another group of small perforated tubercles and a copious granulation ; the crescentic depressions, subanal fasciole, and this group form together a triangle, the base of which lies before the anus, and its apex points towards the mouth ; around this opening five pair of short poriferous zones indicate the termination of the ambulacral areas.

Affinities and differences.—The form of the ambulacral areas, the shortness of the anterior poriferous zone, and the size and depth of the areolar spaces around the cylinders of the large tubercles, together with the carinated elevation in the middle of the interambulacrum, form a group of organic characters which sufficiently distinguish this species from its congeners. In *Spatangus Desmarestii*, which is found with *S. Hoffmanni* in the same beds in Westphalia, the size of the test, the absence of very deep areolas on the dorsal surface, the equal length of the poriferous zones of the anterior ambulacra, and the much smaller tubercles at the base, easily enable us to distinguish it from *S. Hoffmanni*.

Stratigraphical range and localities.—It is found at Malta in bed No. 4, the calcareous sandstone, and in Westphalia ; it has been collected from the Miocene at Doberg near Bünde, and at Astrapp near Osnabruck.

Spatangus De Koninckii, Wright, n. sp.

Test cordate, depressed before, elevated behind by the development of dorsal and basal median carinæ on the single interambulacrum ; ambulacral areas short and broadly petaloid ; anteal sulcus slight ; depression of the single ambulacrum inconsiderable ; several large tubercles between the petaloidal ambulacra ; posterior border obliquely truncated downwards and forwards ; anal opening large and circular ; basal tubercles of moderate size ; basal portions of the postero-lateral ambulacra form two smooth tracks destitute of tubercles between the posterior border and the mouth.

Dimensions.—Antero-posterior diameter $1\frac{6}{10}$ inch ; transverse diameter $1\frac{4}{10}$ inch ; height at the interambulacrum $\frac{1}{10}$ ths of an inch.

Description.—An imperfect specimen of this Urchin was at first mistaken for a small variety of *Spatangus Desmarestii*, Goldf., and entered under that name in the list of fossils from bed No. 2. Having lately obtained a better specimen of this form, we are now enabled to give a description of it, which will be found to differ in many essential points from that species, to which it was at first referred. The test is regularly cordate,

slightly flattened at the cheeks, bulging out at the sides, and from thence tapering abruptly towards the posterior border, where it is truncated obliquely downwards and forwards; the anterior part of the test is flattened and depressed, and the posterior portion much elevated, from the circumstance of the single interambulacrum forming two prominent ridges, one on the dorsal, and the other on the basal surface, which gives increased depth to the test, tilts it up, and forms an inclined plane of the dorsal surface. The petaloidal ambulacra are short, broad and leaf-like; the anterior pair are slightly flexed forwards and form an angle of about 15° ; their anterior poriferous zone is nearly as complete as the posterior zone, which contain respectively sixteen and eighteen pairs of pores; the posterior pair form two oval leaflets, the bases and apices of which are nearly equally curved, and closed with pores, having about eighteen pairs of pores in each zone; they describe an angle of about 60° . The single anterior ambulacrum makes a very slight depression on the upper part of the anterior region, and the anteal sulcus formed by it is inconsiderable when compared with other congeneric forms; the anterior and lateral pairs of interambulacra carry a few large crenulated and perforated tubercles on the upper part of their dorsal surface; on the anterior pair there are from seven to eight, and on the posterior pair from four to five of these tubercles, which are neither so large nor yet have such deep areolas as their homologues in *S. Hoffmanni*. The single posterior interambulacrum is narrow, but greatly developed in the vertical diameter; above, a blunt prominent ridge commences near the apical disc and extends to the posterior border; below, another ridge commences a short distance from the truncated portion of the border, and extends to the centre of the mouth; the base is slightly convex from side to side, besides being raised in the middle of its posterior part by the ridge just alluded to. The tubercles on the basal portions of the anterior and posterior interambulacra are not very large, but are disposed with great regularity; those on the ridge-like prominence of the single interambulacrum are arranged in lines which radiate in all directions from a point; those on the pairs gradually decrease in size from the mouth to the border; between these two groups of tubercles there is on each side a smooth track, corresponding with the course of the postero-lateral ambulacra from the border to the mouth: the anus is large and circular, and occupies the upper part of the posterior border; the subanal fasciole is denuded; the mouth is likewise large and transversely oval, and is situated near the anteal sulcus. The apical disc is excentral, being situated about the anterior part of the middle third of the test; it is small, and is perforated with four genital holes. The

superficial layer of the calcareous plates, which carries all the fine sculpture of the test, is almost entirely denuded from the dorsal surface; one or two fragments alone remain to show that the tuberculation was minute and close-set.

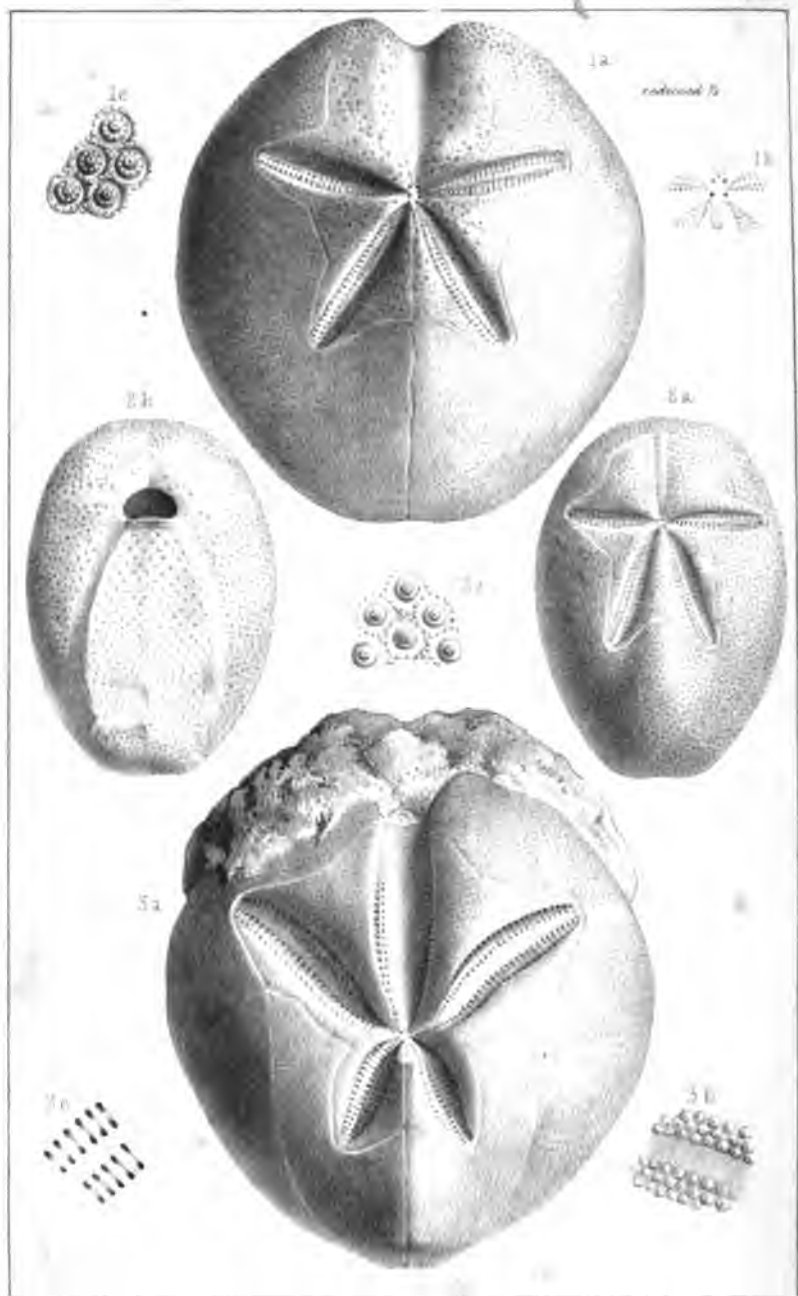
Affinities and differences.—This species is distinguished from *S. Hoffmanni* by the excessive elevation of the posterior part of the test; by the shorter, wider and more oval form of the petaloid ambulacra; by the poriferous zones of the anterior pair being more complete; by the large dorsal tubercles being smaller and fewer in number; by having a less impressed anteal sulcus; a convex base, with smaller tubercles; a ridge-like projection, with a regular tuberculation of the basal portion of the interambulacrum, with smooth naked ambulacral tracks on each side thereof. From *S. Desmarestii* it is distinguished by its short, broad, petaloidal ambulacra, which are long and attenuated in *S. Desmarestii*; by the greater size, number and regularity of the large dorsal tubercles, which are few, small and scattered in *S. Desmarestii*; the posterior region is not at all elevated in *S. Desmarestii*, and the anus is transversely oblong, whilst in *S. De Koninckii* the posterior part is much elevated, and the anal opening is round.

S. Desmarestii has a few groups of large tubercles on the upper part of the single interambulacrum, which are entirely absent both in *S. Hoffmanni* and *S. De Koninckii*. The basal region is so much covered up with matrix in the specimen of *S. Desmarestii* before us, that we cannot institute a comparison between this portion of its test and that of *S. De Koninckii*.

Locality and stratigraphical range.—The two or three specimens we have seen in the Earl Ducie's cabinet were collected from the clay bed No. 2 at Malta; they have all a deep ferruginous colour, and are not well preserved. We dedicate this species to our friend Dr. De Koninck of Liège, the learned author of several memoirs on the palæontology of the carboniferous rocks of Belgium.

Genus *BRISUS* (Klein, 1734).

Form oval; the ambulacral summit excentral, and situated near the anterior border; the antero- and postero-lateral ambulacral areas straight, and lodged in shallow depressions of the test; the anterior pair are nearly transverse, the posterior pair deviating slightly from the longitudinal direction. The single ambulacrum very simple in structure; no anteal sulcus; the peripetal fasciole very sinuous; mouth large, labiate, and near the anterior border; anal opening large, situated in the middle of the posterior surface; the subanal fasciole approximated close



1 a - c *Brissus latus*.
 2 a - c *Brissus oblongus*.
 3 a - c *Schizaster* Parkinson.

Wright.
 Wright
 DeFrance

to the anus. Four genital pores, the anterior pair smaller and nearer each other than the posterior pair. The madreporiform tubercle situated between the posterior genital openings; five perforated ocular plates placed before the genital pores and alternating with them. This genus contains a greater number of living than of fossil species; the existing forms are limited to the seas of warm latitudes; the fossil species are found only in the tertiary rocks.

Brissus latus (Wright, n. sp.). Pl. V. fig. 1 a-c.

Test convex and much depressed above; transverse and antero-posterior diameters nearly equal; ambulacral areas of nearly equal length; the single ambulacrum lodged in a deep anteal sulcus; antero-lateral pair curved gently forwards; peripetal fasciole very zigzag and angular; apical disc $\frac{5}{10}$ ths of an inch before the centre of the disc; base slightly convex; sternal process of the single interambulacrum raised before the anus, having a central elevated ridge and numerous large tubercles arranged in regular order on its surface; subanal fasciole enclosing a space $1\frac{7}{10}$ inch in diameter; anus situated in an oblique truncation below the margin; mouth $\frac{7}{10}$ ths of an inch from the anterior border; the large tubercles of moderate size.

Dimensions.—Antero-posterior diameter $4\frac{1}{10}$ inches, transverse diameter $3\frac{2}{10}$ inches; height at the vertex 1 inch.

Description.—This *Brissus* is readily recognized by its broad and depressed dorsal surface; the ambulacral areas form deep depressions in the test; the single ambulacral area lies in an inconsiderable valley on the dorsal surface, but forms rather a deep anteal sulcus; the antero-lateral pair curve gently outwards and forwards, forming an angle of 21° , with the transverse line at right angles with the longitudinal axis of the test; the postero-lateral pair are directed obliquely backwards at an angle of 55° ; both pairs lie in rather deep valleys, and the poriferous zones contain from twenty-eight to thirty pairs of pores in each avenue. The peripetal fasciole (1 a) makes an angular zigzag track, closely embracing the apices of the ambulacral areas. In the space which it bounds on the fore part of the shell, having for its base the antero-lateral areas, and its apex the anteal sulcus of the single ambulacrum, a number of large perforated tubercles set on crenulated eminences are arranged in groups (1 c), the areolas of these tubercles are surrounded by small granules, and amongst them smaller tubercles are interposed; a few large tubercles occupy the angles between the apices of the antero-lateral and postero-lateral pairs, and likewise in the angle formed between the pos-

tero-laterals themselves; the rest of the dorsal surface is covered with small tubercles closely set together; each tubercle is perforated and raised on a crenulated eminence (1 c), and surrounded by a smooth depressed areola; the base is slightly convex; the sternal portion of the single interambulacrum is rather prominent behind, but slopes gently towards the mouth; it has an elevated ridge in the centre, and is covered with tubercles of a larger size than those of the upper surface, and which are arranged in regular rows. The subanal fasciole is of considerable extent, it forms a semicircle which passes across the most prominent part of the base, and sends its cornua upwards at a considerable distance from the anus; the basal portions of the pairs of the interambulacral areas are covered with tubercles similar to those on the sternal part; a naked track corresponding to the postero-lateral areas separates these tuberculated portions of the base. The mouth is situated near the anterior border, it is widest in the transverse diameter, and has a thick projecting under lip; the terminations of the ambulacral areas surround the mouth, and form poriferous zones around that opening: the anus is situated beneath the margin in an oblique truncation of the posterior border; the opening is much crushed in our specimen, so that its form is not discernible. The apical disc (1 d) is placed near the centre of the back, about $\frac{1}{10}$ ths of an inch before that point: the madreporiform tubercle is small and pyriform, and is situated behind the four genital pores: the margin of the shell is thin and acute.

Affinities and differences.—The breadth of the test and the depression of the dorsal surface thereof, with the curve forwards in the ambulacral areas, and the depth of the anteal sulcus, form a group of characters by which *Brissus latus* is readily distinguished from its congeners. Out of the seven fossil species, registered but not described in Agassiz and Desor's Catalogue, two only are figured, and for this reason we are unable to make a comparison with them.

Locality and stratigraphical range.—Only one specimen of this species, in the Earl Ducie's cabinet, was collected from bed No. 1, the Gozo marble, at Malta, so that we conclude the species is rare, as it is not contained in either of the other collections of Maltese Urchins examined by us. The Jermyn Street Museum contains a specimen, which is supposed to be identical with this form.

Brissus imbricatus (Wright, n. sp.).

Test oblong, much depressed; no anteal sulcus; peripetal fasciole narrow, lodged in a groove; rest of the dorsal surface fractured; base convex; mouth large, and situated near the ante-

rior border; sternal portion of the interambulacrum with a regular ornamentation. The subanal fasciole very near the anus is heart-shaped and narrow; it encloses rows of tubercles which are arranged in radii in regular order; before the fasciole the test forms a projection, and from the summit thereof, rows of tubercles arranged in straight lines extend towards the mouth, increasing in size as they approach that opening; the basal portions of the other interambulacral areas are covered with scale-like imbricated plates, each carrying an oval eminence with a crenulated summit, and a tubercle placed at the anterior side of the oval eminence; these tubercles are all regularly arranged in rows which have a direction forwards and outwards: the postero-lateral ambulacra form a naked space, which separates the imbricated basal portions of the pairs of interambulacra from the ornamented sternal portion of the single one. The anus is large and situated at the posterior border; both this opening and the mouth are much injured.

Dimensions.—Antero-posterior diameter $3\frac{5}{10}$ inches, transverse diameter 3 inches, height $\frac{8}{10}$ ths of an inch.

Description.—The detailed diagnosis given of this species contains nearly all that we can describe of this *Brissus*, for, with the exception of a small portion of its anterior part preserving a portion of the peripetal fasciole, all the rest is absent; the regularity in the arrangement of the tubercles at the base constitutes a characteristic feature of this form, and the imbricated style of the basal plates, resembling the tegumentary membrane of a placoid fish, gives value to the specific name.

Affinities and differences.—The order and symmetry of the decoration of the sternal portion of the interambulacrum, the heart-shaped subanal fasciole, with its broad band of microscopic granules, and the leaf-like tuberculated expansion which extends from the apex of the fasciole, are very characteristic of this species; if to these we add the imbricated style of the plates occupying the sides of the base, and the oblique way the tubercles are set on their oblong bases, we have an assemblage of organic characters by which *B. imbricatus* may be readily distinguished from its congeners. The form of the test, the size of the tubercles, the symmetry of the subanal rosette, formed by radii of tubercles, and encircled by a broad fasciole, readily separate it from *B. latus*, with which it is associated in the same stratum.

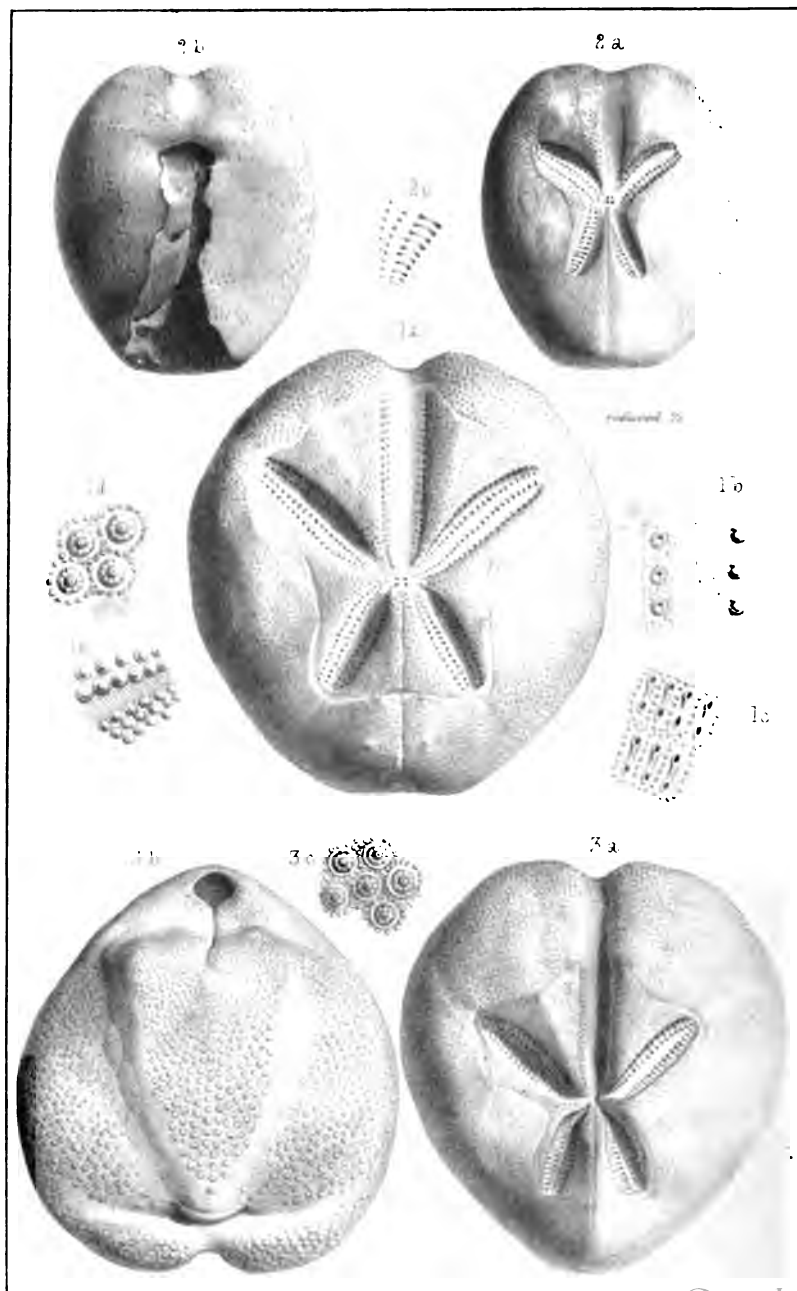
Locality and stratigraphical position.—This species was collected from bed No. 1, the Gozo marble, at Malta: it is the property of the Bristol Institution.

Brissus oblongus (Forbes MSS., n. sp.). Pl. V. fig. 2 a-c.

Test oblong, depressed before, elevated behind; dorsal surface convex; anterior border rounded, with a slight anteal sulcus; antero-lateral ambulacral areas slightly bent forwards, and nearly forming right angles with the longitudinal axis; postero-lateral ambulacra make an angle of 68° ; the anterior are shorter than the posterior pair; posterior border produced and truncated: anus large, oval, and placed high up: base convex, sternal portion prominent, greatest width across the base of the postero-lateral ambulacra.

Dimensions.—Antero-posterior diameter $2\frac{1}{10}$ inch, transverse diameter $1\frac{9}{10}$ inch, height $1\frac{1}{10}$ inch.

Description.—This small *Brissus* has an oblong form, and is rounded before and truncated behind; the anterior half of the test is more depressed than the posterior half; the single interambulacrum rises into a ridge-like eminence on the back, and the sternal portion thereof is much inflated at the base, so that the greatest height of the test is in this region. The antero-lateral ambulacra (2 a) are shorter than the posterior pair, and are extended across the test nearly at right angles to the longitudinal axis; the postero-lateral ambulacra are longer than the anterior, and form angles of 68° ; the petaloid portions of both areas are depressed; the anterior pair have eighteen pairs of pores, the posterior pair have twenty-four pairs of pores in their poriferous zones: the single ambulacrum is not lodged in a rudimentary anteal sulcus, and is nearly on a level with the contour of the test, the front and cheeks of which are convex, with four groups of larger tubercles in this region; the sides slope obliquely downwards to the border, which is obtuse: the single interambulacrum is raised into a ridge above, and produced into a blunted caudal process, obliquely truncated behind: the base (2 b) is convex, chiefly from the arched form which the sternal portion of the interambulacrum assumes: the mouth is large, near the anterior third of the base: the anus is of an elliptical form, and occupies more than the upper half of the truncated portion of the posterior border. The peripetal fasciole (2 a) closely embraces the ambulacral pairs, and makes three angles in passing over the anterior interambulacra; the subanal fasciole (2 b) describes a heart-shaped outline, its base is near the anus, and its apex touches the prominent point of the sternum; the space thereby circumscribed is filled with tubercles having a definite arrangement. The apical disc is small, with four genital pores, the posterior pair being much larger than the anterior pair; the tubercles (2 c) on the anterior interambulacra are much the largest, those on the rest of the back are small and very uniform in size, whilst those on the sternum and the sides



1. Brachiopteria

1a. Brachiopteria

1b. Brachiopteria

2a. Brachiopteria

2b. Brachiopteria

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of the base are intermediate in size; the basal tracts of the ambulacral areas are destitute of tubercles; as they approach the mouth they are again perforated with a single row of holes; those of the antero-laterals extend as far as the border, whilst the single and posterior pair have only two or three pairs of their plates perforated.

Genus *BRISSOPSIS* (Agassiz, 1840).

Form elongated, subcylindrical; ambulacral areas straight, short, and wide, converging near the summit of the test; peripetal fasciole flexuous, closely surrounding the ambulacral areas; two or four genital pores, the posterior larger than the anterior pair; five ocular plates disposed nearly equally apart in a pentagonal form around the genital openings; subanal fasciole wide, and situate at a considerable distance below the anal opening; single ambulacrum lodged in an antea sulcus; the basal portions of the ambulacra are wide and naked; the tubercles are very uniform in size, and are crenulated and perforated. Three living species; the rest are fossil in the tertiary rocks.

Brissopsis Duciei (Wright, n. sp.). Pl. VI. fig. 1 *a-e*.

Test oblong, depressed anteriorly, elevated posteriorly; apical disc central; ambulacral areas forming concave depressions; single ambulacrum the longest and widest; antero-lateral pair straight, angle of inclination 34° ; postero-lateral shorter, angle of inclination 55° ; peripetal fasciole broad and undulating; anus oval, large, situated high on the border; base concealed; dorsal tubercles small, nearly of a uniform size, except on the sides and the anterior part, where they are larger.

Dimensions. — Large specimen. Antero-posterior diameter $3\frac{4}{10}$ inches, transverse diameter $3\frac{2}{10}$ inches: height cannot be accurately measured.

Small specimen. Antero-posterior diameter $1\frac{9}{10}$ inch, transverse diameter $1\frac{7}{10}$ inch; height over the middle of the single ambulacrum $\frac{9}{10}$ ths of an inch, at the highest point of the dorsal region $1\frac{1}{10}$ inch.

Description. — This beautiful Urchin is one of the most typical forms of the group to which it naturally belongs. The test is oblong and inclined, from the height of the anterior third being less by $\frac{9}{10}$ ths of an inch than the posterior third; the ambulacral areas are all well developed, and arranged in the form of a St. Andrew's cross; as the apical disc is situated near the centre of the body, the regularity of their arrangement forms a conspicuous character of this species. The anterior ambulacrum (1 *a*) is concave, and makes an inconsiderable antea sulcus; there is a

single row of pores, flanked by a row of tubercles on each side, with a space between filled by a microscopic granulation; it is abruptly bounded below by the fasciole, and terminates at the disc in a blunt lancet-shaped apex. The antero-lateral ambulacra in the large specimen are $\frac{5}{10}$ ths of an inch longer than the posterior pair, and form an angle of 37° with the transverse line through the disc; they are round at the base and blunted at the apex, and the anterior side is more rounded off than the posterior for the reception of the apex of the ambulacrum; in the anterior zone there are twenty, and in the posterior zone twenty-four pairs of holes. The postero-lateral pair describe an angle of 55° ; both pairs form concave valleys; the pores in the zones are of the same size, and are pierced so wide apart (1 c) that the pores of each pair are nearly as distant from each other as the width of the space which separates the two avenues; in the anterior ambulacral avenues there are twenty in the anterior and twenty-four in the posterior zone; in the posterior pair the numbers are twenty-two before and eighteen behind. The peripetal fasciole (1 e) has an unequal width in different parts of its track; it is narrow where it passes over elevations of the test, or is bent into angles, and becomes wider in other parts of its course. The apical disc (1 a) is small, heart-shaped and central; the two anterior genital holes are smaller and placed closer together than the posterior pair; the five eye-holes as usual are situated at the summit of the ambulacral apices: the madreporiform tubercle occupies the surface of the posterior triangular genital plate. The anus is a large oblong opening, situated in the upper half of the posterior border, at the distance of $\frac{7}{10}$ ths of an inch from the fasciole in the small individual. The base in both specimens is concealed; the tubercles (1 d) are small, crenulated and perforated, and nearly of the same size; a few larger ones occupy the sides of the anterior ambulacral sulcus; the sides of the ambulacral areas and as much of their basal portions as is exposed are destitute of tubercles.

Affinities and differences.—*Brissopsis Duciei* is readily distinguished from the other forms of this genus met with in the Maltese beds, by the full development of its ambulacral areas, their straightness, width and depth. The double crescent formed by the ambulacral areas in *B. crescenticus* is a sufficient character by which it may at a glance be distinguished from *B. Duciei*.

Locality and stratigraphical position.—This species was collected from bed No. 1, the Gozo marble, at Malta, where it is rare; the two specimens before us are the only ones we have seen. We dedicate this fine species to the Earl Ducie, whose valuable collection of Maltese fossils has added to our previous knowledge of the palæontology of the island, and whose geological map of

Malta so well exhibits the distribution of the various beds with their faults and denudation.

Brissopsis crescenticus (Wright, n. sp.). Pl. VI. fig. 2 a-c.

Test oblong, rounded before and truncated behind; flattened on the dorsal surface, and deeply indented by the ambulacral areas; the ambulacrum forms an anteal sulcus; the anterior and posterior ambulacra on each side form two lateral crescents that abut at the longitudinal line; the antero-lateral pair are the longest and widest, they curve forwards and backwards, and the posterior pair curve backwards and forwards; the anterior pair form an angle of 45° , the posterior pair an angle of 65° ; the apical disc lies in a depression formed by the confluence of the apices of all the ambulacra; the posterior border is squarely truncated, with the anal opening in its upper angle; the base is convex, with few tubercles and wide naked spaces formed by the basal portions of the ambulacra; the mouth is situated in the anterior third.

Dimensions.—Antero-posterior diameter $1\frac{6}{10}$ inch, transverse diameter $1\frac{4}{10}$ inch, height $\frac{8}{10}$ ths of an inch.

Description.—The most remarkable feature in this species consists in the mode of arrangement of the ambulacra; the anterior and posterior areas of each side curve in opposite directions and form crescents, the convexities of which are directed towards the middle line of the test, and give value to the name proposed. The antero-lateral pair form an angle of 45° ; they are about the same length as the posterior pair, but are a little broader and are more divergent: there are nineteen pairs of holes in the external zone, and fourteen in the inner; the posterior pair are nearly parallel with each other, and have a slight curve forwards to form the posterior horn of the crescent; they are not so much developed as the anterior pair; the external zone of holes contains fifteen pairs, but the inner zone (2 c) is imperfectly developed, from their close approximation to those of the opposite area: the apical disc is small; the four genital holes are large, the anterior pair being more closely approximated than the posterior pair; it is situated nearer the anterior than the posterior border and lies in a confluent depression, in which the apices of all the areas freely converge. The single ambulacrum is rather longer, but not so wide as the anterior pair; its lateral row of single holes, with their accompanying tubercles, are small and indistinctly seen, and it forms an inconsiderable anteal sulcus: the posterior border is squarely and obliquely truncated, and in its upper part near the dorsal surface is the large anal opening: the base is rather convex; the sternal portion of the single interambu-

lacrum is slightly prominent, and ornamented with a few rows of rather larger tubercles disposed in zigzag lines: the basal tracks of the ambulacral areas are entirely naked, and where they terminate around the mouth five petaloid poriferous radii are observed. The mouth, of moderate size, is in the anterior third; the peripetal fasciole is narrow and indistinct; the subanal fasciole is much broader, and remote from the anus, but the test is unfortunately broken in this region; the tubercles are nearly all of the same size, but a few larger ones occupy the sides, front, and base.

Affinities and differences.—The flatness of the dorsal surface, the deep depressions made by the petaloid portion of the ambulacral areas, and the double crescent formed by them, readily distinguish *B. crescenticus* from its congeners. So few fossil species of this genus have been figured or described, that we can only compare it with the other forms obtained from the same bed, from both of which it differs in many well-marked characters.

Locality and stratigraphical position.—It was collected from bed No. 4, the calcareous sandstone at Malta, where it is rare.

Genus HEMIASTER (Desor, 1847).

Urchins with a high and much inflated test; ambulacral summit nearly central; the petaloid portions of the ambulacral areas situated in depressions more or less deep; the antero-lateral are in general much longer than the postero-lateral pair; the peripetal fasciole only surrounding in an angular manner the ambulacral star. This genus differs from *Micraster* in all the species having a more inflated body with a peripetal fasciole; from *Brissopsis* in having the postero-lateral ambulacra in general much shorter, and the anterior and posterior pairs more unequal in length, and likewise in having no subanal fasciole. A very few species are found in the tertiaries, the majority belonging to the cretaceous rocks.

Hemiaster Grateloupi (Sismonda sp.).

SYN. *Schizaster Grateloupi*, E. Sismonda, Echin. Foss. Piem. p. 27. tab. 2.

Hemiaster Grateloupi, Desor, Ann. Sc. Nat. tom. viii. p. 19.

Test orbicular, convex above and below, with tumid inflated sides: the single ambulacrum short, shallow and narrow; the antero-laterals long, deep and diverging; angle of inclination 25° ; the postero-lateral pair slightly curved inwards; angle of inclination 62° ; both pairs lie in deep depressions: the peripetal fasciole broad and undulating: the single interambulacrum forming a dorsal ridge: posterior border abruptly trun-

cated: anal opening high near the upper surface: apical disc small and central.

Dimensions.—Antero-posterior diameter $2\frac{3}{10}$ inches, transverse diameter 3 inches, height $1\frac{1}{10}$ inch.

Description.—The orbicular form and inflated sides of this Urchin, with its large, deep, diverging ambulacra, and greater diameter in the transverse than in the longitudinal direction, impart to it an air which widely distinguishes it from other Hemiasters. The single ambulacrum is narrow and shallow, and forms an inconsiderable anteal sulcus, which measures $1\frac{1}{4}$ inch in length from the apex to the fasciole; it has a single row of lateral holes and accompanying tubercles of small size placed near each other within, and the holes only at considerable distances apart without the fasciole. The antero-lateral ambulacra are rather wider and much deeper than the single area; they are $1\frac{2}{10}$ inch in length, and are directed forwards and outwards, forming an angle of 25° ; the walls of the depression are formed by the poriferous zones, and the base by the intervening smooth space between them: the postero-lateral ambulacra are directed obliquely backwards and gently curved inwards; they are 1 inch long and form an angle of 62° : the peripetal fasciole closely embraces the base of the areas, and maintains a nearly uniform width throughout its course: the test is very much inflated anteriorly and laterally, and its posterior border is abruptly truncated: the single interambulacrum is elevated into a ridge, which rises between the two posterior ambulacra, at the termination of which the anal opening is situated: the test is covered with small, nearly equal-sized tubercles, which are larger on the fore-part, cheeks, and sides than elsewhere: the apical disc is small, and lies in a depression at the centre of the test, the apices of the interambulacra rising into little eminences around it: the base is entirely concealed by the matrix.

Affinities and differences.—This large species differs so much from its congeners in its breadth, in the depth and divergence of the antero-lateral ambulacra, which are likewise slightly curved forwards, in the length and depth of the posterior pair, which equal the single ambulacrum in length, in the breadth and extent of the peripetal fasciole, and the perpendicular truncature of the posterior border, with the general tumidity of its sides, that it is readily distinguished from them.

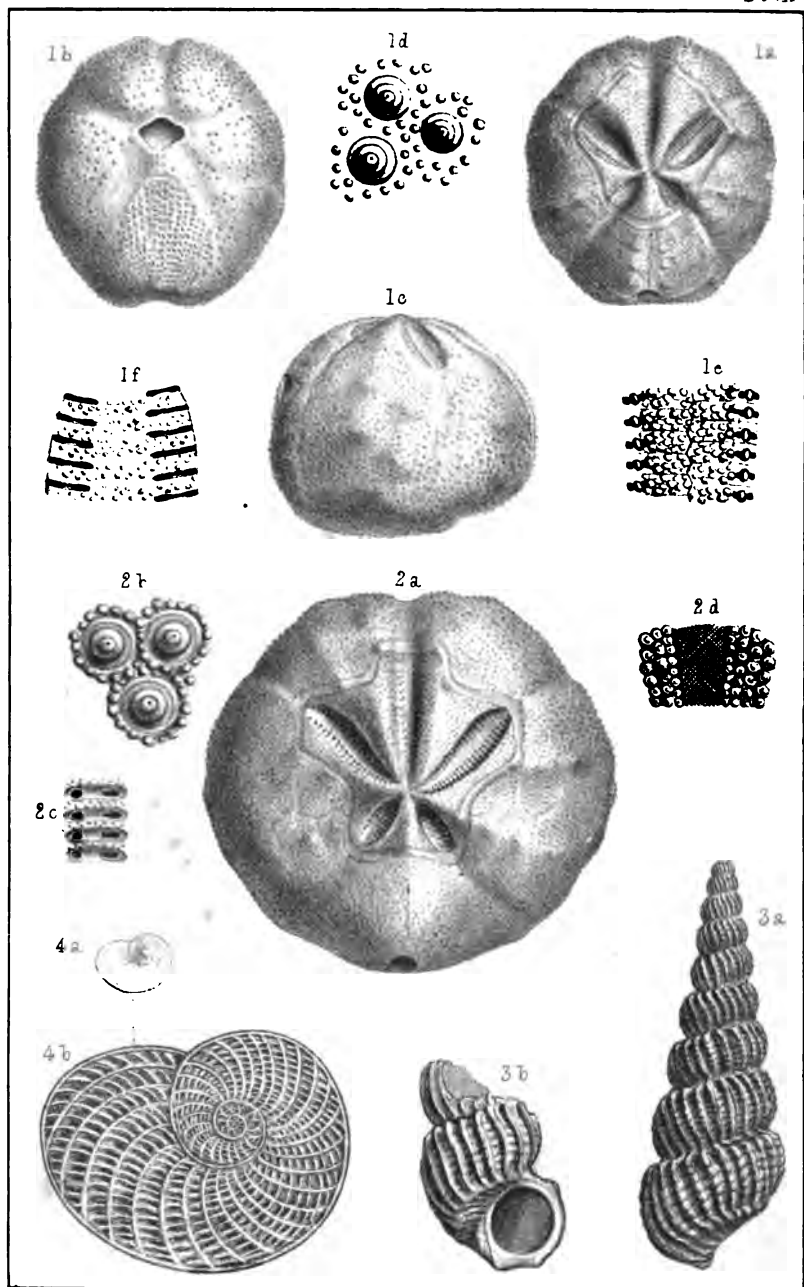
Locality and stratigraphical position.—It was collected from bed No. 4, the calcareous sandstone at Malta, and is one of the few tertiary Urchins in our cabinet; it is the only specimen of the species we have seen.

Hemiaster Cotteaui, Wright. Pl. VII. fig. 2 a-d.

Test orbicular, globose, much inflated, declining anteriorly, elevated posteriorly, the interambulacrum forming a prominent carina which terminates in a tail-like process above the anus; posterior border obliquely truncated; ambulacral areas deeply sunk; an anteal ambulacrum forms the sulcus in the anterior border; antero-laterals long, and inclined to 45° ; postero-laterals one-half the length of the anterior pair, inclined to 57° ; apical disc nearly central; peripetal fasciole broad and undulating; anus high under the carinal process; tubercles larger on the sides and base than on the dorsal surface; mouth labiate near the anterior border.

Dimensions.—Antero-posterior diameter $1\frac{1}{2}\frac{2}{8}$ inch, transverse diameter $1\frac{1}{2}\frac{1}{8}$ inch, height $1\frac{1}{2}\frac{1}{8}$ inch.

Description.—This Urchin has a globose form, and is much inflated at the sides; the dorsal surface is convex, and declines much more rapidly from the apical disc to the anterior border, than from the disc to the posterior border. The ambulacral areas (2 a) are all deeply sunk; the single ambulacrum is the longest, and forms a considerable anteal sulcus; the antero-lateral pair have a gentle double curve; they are $\frac{7}{10}$ ths of an inch in length, and form an angle of 45° . The number of pores (2 c) in the avenues is twenty-two pairs in the inner, and twenty-four in the outer zone; the postero-lateral pair are scarcely half the length of the anterior pair; they incline at 57° ; their number of pores is ten and twelve pairs. The peripetal fasciole (2 d) closely embraces the ambulacral star; a naked track proceeds from the base of the antero-laterals to the mouth, indicating the course of the imperforate portion of the ambulacral areas: the rapid declivity of the anterior part of the test strongly contrasts with the inflated condition of the sides and the elevation of the interambulacrum; from the centre of this area a ridge rises which is produced into a tail-like process, and beneath, the posterior border is scooped out, and truncated obliquely downwards and inwards. The anus is situated high up, immediately beneath the caudal prolongation; the base is convex, and a partially naked space on each side of the sternal portion of the interambulacrum, indicates the track of the basal portions of the posterior ambulacra. The tubercles of the upper surface (2 b) are smaller and more closely set together than those on the sides and base, where they are larger, wider apart, and more fully developed. They are perforated and uncrenulated, and surrounded by a circle of small tubercles. *H. Cotteaui* resembles *Spatangus (Hemiaster) acuminatus*, Goldf., but it is more globose, and its posterior half is neither so elevated, nor yet so wedge-



W. H. Barby, del et lith.

1. a-f Hemaster Scilla,
2. a-d Hemaster Cotteau,
3. a-b Scalaria Ducre,
4. a-b Lenticulites complanatus,

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 Wright, lith. by Google
 Wright
 De France.

shaped as that species; the single ambulacrum is larger and wider, and the antero-lateral pair are more developed in the German than in the Maltese form; they resemble each other in the interambulacrum in both possessing a tail-like terminal process, and in having the posterior border obliquely scooped out; they are both, likewise, Miocene Urchins, *S. acuminatus* being found in that terrain near Cassel and Düsseldorf (Germany), and at Bordeaux and Blaye (France).

Affinities and differences.—The depth and length of the ambulacral areas, with the great declivity of the anterior side of the test, and the post-discal carina, with its caudate-like process, serve to distinguish this species from *H. Scilla*.

Locality and stratigraphical position.—Collected from bed No. 4, the calcareous sandstone at Malta. We dedicate this species to our friend M. Cotteau, the learned author of 'Études sur les Échinides Fossiles du département de l'Yonne,' who has most generously aided us in our studies, by contributing the types of many of his species to our cabinet for comparative investigations.

Hemiaster Scilla, Wright, n. sp. Pl. VII. fig. 1 a-f.

SYN. *Spatangus crassissimus*, Desmoulins, Études sur les Échinides, p. 394. no. 30.

Echinus, Scilla, Corp. Mar. pl. 10. fig. 4.

Test globular, higher behind than before; ambulacral areas short; single ambulacrum the longest, forming a deep sulcus on the anterior border; antero-laterals wide, diverging at an angle of 44° ; postero-laterals not half the length of the anteriors, forming an angle of 56° ; both pairs form sulci on the sides of the test: posterior border squarely truncated downwards and outwards: the anus high near the dorsum: base convex: mouth at the anterior third, with a large projecting under lip.

Dimensions.—Antero-posterior diameter $1\frac{2}{30}$ inch, transverse diameter $1\frac{7}{30}$ inch, height $1\frac{4}{30}$ inch.

Description.—Much confusion has arisen as to the identity of this Urchin, occasioned probably by the circumstance of Scilla having figured only the base of the test, and neglected to give either its profile or the dorsal surface. In M. Agassiz's 'Prodromus' it was entered as *Micraster Goldfussii*, but has been omitted from Agassiz and Desor's 'Catalogue raisonné.' M. Desmoulins identifies it with the *Spatangus crassissimus* of DeFrance, but on referring to the original description* of that species, we find that DeFrance's species came from "la craie

* Dict. Sc. Nat. tom. 50. p. 96.

chloritée near Havre," and as no species of Urchin known to us passed from the secondary to the tertiary epoch, we must reject the high authority of this most accurate naturalist, and consider the Urchin before us as distinct from *S. crassissimus*. The test inclines to an oblong form (1 c); it is higher behind than before, and declines more rapidly from the disc to the anterior border than from the disc to the anus. The ambulacral areas lie in deep depressions; the single ambulacrum (1 e) is the longest, and forms an inconsiderable anteal sulcus; the antero-laterals are $\frac{4}{10}$ ths of an inch in length, and form an angle of 44° ; the number of the pores (1 f) in the zones is fifteen and twenty: the postero-laterals are scarcely one-half the length of the antero-laterals; they form an angle of 56° ; the number of pores in them is respectively seven and ten: the peripetal fasciole is broad, but feebly marked, and closely embraces the bases of the areas: four sulci (1 a), nearly destitute of tubercles, mark the course of the ambulacra from the side of the fasciole to the mouth: the lateral interambulacra are rather inflated, and marked by five or six angular elevations (1 c) of the test: the single interambulacrum is elevated on the dorsum (1 a), squarely truncated on the posterior border, and convex beneath: the small oval anus is situated very high up, about $\frac{6}{10}$ ths of an inch from the disc: the sternal portion of the interambulacrum (1 b) is convex and prominent, and is covered with close-set tubercles, arranged in lines, proceeding like radii from a central point of the base: the mouth has a large projecting under-lip. The upper part of the shell is covered with small close-set uncrenulate tubercles (1 d), which are larger and irregularly disposed on the front and base: the apical disc is small and nearly central: there are only two genital holes at the apices of the lateral ambulacra: the five eye-holes are very small. Whether one pair of genital holes may be a generic character of *Hemiaster*, we have not the means at present of determining, as most of our specimens of this group have the disc concealed; but about the beautiful *H. Scillæ* now before us there can be no question.

Affinities and differences.—The absence of the dorsal carina and caudal process serve to distinguish *H. Scillæ* from *H. Cotteauii*; the latter is likewise a more globose and less elegant form of Urchin, and has the truncature of the posterior border downwards and forwards, whereas in *H. Scillæ* the direction is downwards and backwards.

Locality and stratigraphical position.—Collected from No. 4, the calcareous sandstone at Malta, from whence the original specimen figured by Scilla was obtained: this reason will suffice for the name we have given it.

Genus PERICOSMUS (Agassiz, 1847).

In addition to the general characters of *Hemiaster*, these Urchins have an arched arrangement of the peripetal fasciole and a narrow marginal fasciole, which can be traced round the anterior border, extending along the sides, passing beneath the anus, meeting its fellow from the opposite side, and thereby encircling the test. All the species of this small group have been obtained from strata of the Miocene age.

Pericosmus latus, Desor.

SYN. *Micraster latus*, Agassiz, Cat. Syst. p. 2.

Pericosmus latus, Agassiz and Desor, Cat. raisonné, Ann. Sc. Nat. tom. vi. pl. 16. fig. 1, & tom. viii. p. 19.

Test cordate, broad, convex above, flat below; petaloidal ambulacra straight, deep-sunk and narrow; the posterior nearly as long as the anterior pair; apical discs central; peripetal fasciole closely embracing the ambulacra, with three arches across the single ambulacral depression; marginal fasciole narrow, entirely surrounding the upper part of the border of the test.

Dimensions.—Antero-posterior diameter $2\frac{7}{10}$ inches; transverse diameter $2\frac{7}{10}$ inches; height $1\frac{3}{10}$ inch.

Description.—This rare type of one of the extinct genera of *Spatangida* was at first mistaken for a *Micraster* by Agassiz, and entered in his 'Catalogus Systematicus' under the name *Micraster latus*; the peripetal fasciole, however, readily distinguishes it from *Micraster*, and the marginal fasciole from *Hemiaster*. No doubt many mistakes will be committed regarding this Urchin, as these fascioles are exceedingly delicate, and not always preserved: when they are absent, it then greatly resembles a *Micraster*; but when the marginal fasciole is effaced, and the peripetal remains, it then may be mistaken for a *Hemiaster*; fortunately, in one of the specimens before us, the fascioles are both preserved, and their entire course can be traced. The test has a uniformly curved dorsal surface, with a regular cordate form, the base is slightly convex, and the posterior border is truncated. The petaloid portions of the ambulacral areas are straight, and lodged in rather deep depressions, extended obliquely outwards on the middle of the dorsal surface, in the form of a St. Andrew's cross; the single ambulacrum lies in a deep wide depression, and forms a considerable antea sulcus; at its apical portion only, there are from ten to twelve pairs of ambulacral plates, each perforated in the centre with a single hole; in all the other plates in the area the perforations are obsolete;

the antero-lateral ambulacra, $\frac{1}{8}\frac{5}{8}$ ths of an inch in length, are nearly straight, having only very slight *f*-shaped flexures, which curve forwards and outwards, making an angle of 35° : the two poriferous zones lie close together, in deep narrow depressions; in each zone there are from twenty-four to twenty-six pairs of holes; the space between the pairs of pores is only a little more than that which separates one row of pores from another, so that the pores lie nearly equidistant from each other in the sunken areas; the postero-lateral ambulacra are $\frac{1}{8}\frac{3}{8}$ ths of an inch in length, and are extended backwards and outwards at an angle of 60° ; there are from twenty to twenty-two pairs of holes in each zone, the rows of which, like those on the anterior pair, are nearly equidistant: the peripetal fasciole closely surrounds the posterior ambulacral pair, makes two angles on their sides, and crosses to the anterior pair, where it in like manner forms two angles, then sweeps round the base, and passes in a straight line along the anterior side; from it three branches proceed inwards, which arch over the single ambulacrum, describing angles as they advance to meet the branches from the opposite side; the marginal fasciole is a narrow line, which passes above the fold of the border and entirely encircles the test, dipping into the anteal sulcus in its course, but its position in relation to the anus is not clearly shown in either of our specimens. Agassiz figures it as passing under the anus; in his figure the remarkable arches on the anterior part are not drawn: the apical disc is small, and occupies the centre of the test; it has only two genital holes like a *Hemiaster*, and five small ocular holes; the upper surface of the test is covered with small, nearly equal-sized tubercles, those on the anterior side are a little larger; the base is slightly convex, the lateral interambulacra carry large tubercles on their basal plates, and the sternal portion of the interambulacrum is likewise covered with a regular tuberculation; the basal tracks of the posterior ambulacra are smooth between the border and the mouth; the anus is situated high up on the posterior border, and the mouth lies very close to the anteal sulcus.

Affinities and differences.—The central position of the apical disc and the depth and straightness of the ambulacra distinguish this form from *P. excentricus*; the generic affinities of this small genus have been already pointed out. The rarity of *Pericosmus*, and the small number of species and individuals at present known, limit our comparisons to the forms we have cited.

Locality and stratigraphical range.—This is one of the few Urchins found in the clay bed No. 2 at Malta: we have before us a specimen from Balistro, Corsica, from the miocene beds of

that island, sent us by M. Michelin of Paris; we consider the peculiar arch-like arrangement of the peripetal fasciole, with the marginal, as good generic characters whereby to form a distinct genus.

Pericosmus excentricus, Wright, n. sp.

Test oblong, highly convex above, slightly so below; apical disc very excentral, near the anterior border; ambulacra in shallow depressions; single ambulacrum slightly grooves the anterior border; antero-laterals nearly transverse; postero-laterals incline at 55° ; peripetal fasciole narrow and undulating; marginal fasciole narrow and low on the border; tubercles on the upper surface small, close-set, and nearly all of the same size; a few larger ones on the anterior interambulacra; anus large and situated high on the border; mouth-opening wide in the anterior third, surrounded by five poriferous petaloid zones; sternal portion of the interambulacrum convex, with close-set imbricated tuberculigerous plates; basal portions of the interambulacral pairs with larger tubercles, wider apart, and more irregular than those of the dorsum.

Dimensions.—Antero-posterior diameter 2 inches, transverse diameter $1\frac{8}{10}$ inch, height 1 inch?

Description.—This Urchin is so much crushed that it is impossible to describe its outline. The ambulacral areas form shallow depressions, and the single area slightly grooves the anterior border: the antero-laterals are nearly transverse, their inclination being forwards; they are $\frac{8}{10}$ ths of an inch in length: the postero-laterals form an angle of 55° ; they are $\frac{4}{10}$ ths of an inch long. The crushed state of the test makes it impossible to count accurately the pores, or give the breadth of the areas; the apical disc, with four genital pores, is very small and remarkably excentral, being very near the anterior border; the peripetal fasciole is narrow, angular and undulating, and instead of surrounding the anterior part of the antero-lateral ambulacra, as in *P. latus*, it descends from them and joins the marginal fasciole below their base, so that the anterior sides of the antero-laterals, and the single ambulacrum, want the peripetal fasciole. The specimen before us is so much crushed, that we cannot trace the band continuously all round the test, so as to describe its course with accuracy; it is possible that this species may form the type of a distribution of the fascioles distinct from any that is yet known. We have stated enough to show, that at least in this form there is a considerable deviation from the normal arrangement. The anus is large and oval, and near the dorsum; the mouth is wide and bilabiate, and situated near the border; the sternal portion of the interambulacrum is slightly convex, and thickly covered

with an imbricated arrangement on the plates, on each of which a perforated tubercle is raised. The basal portions of the interambulacral pairs are covered with wider-set tubercles of the same size, and the entire upper surface of the test is crowded with small tubercles closely set together, and very uniform in size and arrangement. The mouth is surrounded by five petaloid poriferous ambulacra.

Affinities and differences.—The excentric position of the disc, with its four genital holes, and the petaloid poriferous ambulacra around the mouth, establish an affinity between this form and *Brissus*. The way in which the peripetal joins the marginal fasciole is similar to what exists in *Schizaster*, whilst the marginal fasciole, entirely encircling the test and passing round beneath the anus, is found only in *Pericosmus*. The excentric position of the apical disc and the shallowness of the ambulacral star form a sufficient diagnosis between this species and *P. latus*.

Locality and stratigraphical position.—Collected from bed No. 1, the Gozo marble at Malta, where it is rare.

Genus SCHIZASTER (Agassiz, 1834).

Urchins with a cordiform test, broad and depressed before, narrow and elevated behind; the ambulacral summit excentric and nearer the posterior border; the petaloid ambulacra lodged in very deep depressions, the antero-lateral much longer than the postero-lateral pair; the single ambulacrum long and deeply sunken in the anteal sulcus; the peripetal fasciole surrounds the ambulacral star, and from one of the antero-lateral angles thereof, a second postero-lateral fasciole arises, which passes downwards and backwards along the sides and under the anus, where it joins its fellow of the opposite side; the genital pores are two in number from the fusion of the anterior and posterior pairs; the five ocular plates are small and lodged in depressions; the eye-holes are microscopic. *Schizaster* differs from *Hemiaster* in possessing a postero-lateral fasciole, and in having the antero-lateral ambulacra less divergent and lodged in deeper depressions; the anteal sulcus is also much deeper.

Schizaster eurynotus, Agassiz.

SYN. *Echinus Spatangus compressus et lapidescens in Melitensi topho*, Scilla, Corp. Mar. tab. 7. fig. 1.

Echinus gladius vestitus et nudus Imperati, Klein, Echinod. p. 35. tab. 27 A.

Spatangus lacunosus, Leske, no. 77. p. 227.

Spatangus canaliferus, Lamarck, Anim. sans Vert. 2nd ed. tom. iii. p. 327; Grateloup, Foss. Ours. Dax, p. 67.

Schizaster eurynotus, Sismonda, Mem. Echin. Foss. Nizza, tab. 2. fig. 3. p. 31; Agassiz and Desor, Ann. Sc. Nat. tom. viii. p. 21. série 3.

Spatangus Scillæ, Desmoulins, Etudes-sur les Echin. no. 24. p. 392.

Test heart-shaped, depressed and rounded anteriorly, elevated and pointed posteriorly; ambulacral areas deeply excavated; the single ambulacrum long, deep, wider in the middle and narrower at the anterior border, which is deeply grooved by it: antero-laterals slightly *f*-shaped; angle 52° ; length $1\frac{5}{8}$ inch: postero-laterals, angle 72° , short, $\frac{7}{10}$ ths of an inch; apical disc with two genital holes near the posterior third; single interambulacrum elevated into a prominent carina terminating in a caudal hooked process.

Description.—This Urchin resembles *Schizaster canaliferus* now living on the shores of the Mediterranean, and for which it has been mistaken by some naturalists, but an attentive study of the living and fossil species discloses characters by which they may be distinguished from each other. The test in *S. eurynotus* is cordate, depressed before and elevated behind. The ambulacral areas are deeply depressed; the odd or anterior ambulacrum is nearly twice the width of the pairs, it swells out in the middle, is blunted at the apex, and most contracted at the anteal sulcus, which is deep and narrow when contrasted with the width it attains above. The poriferous zones lie at the base of the walls of the sulcus; the very narrow plates that compose the floor of this area are each studded with a row of small granules. The antero-lateral ambulacra diverge at an angle of 52° ; they are slightly *f*-shaped, and are $1\frac{5}{8}$ inch in length: the numbers of holes in the zones are thirty-six and thirty-four. The postero-lateral pair are short, and make an angle of 72° ; they are $\frac{7}{10}$ ths of an inch in length, and have respectively twenty-six and twenty-four holes in their zones. The peripetal fasciole passes close to the base of the posterior pair, dips slightly into the space which separates the anterior from the posterior pair, runs at some distance from the anterior pair, passes close by the base thereof obliquely towards the anteal sulcus, into which it dips, and meets its fellow from the opposite side: the very narrow postero-lateral fasciole is directed obliquely downwards and backwards, and unites with its fellow at some distance below the anus. The test is depressed anteriorly and sloped away at the cheeks, whilst behind it is much elevated. The interambulacrum forms an elevated ridge between the posterior ambulacral pair, and is produced into a caudal-like process behind, beneath which the circular anus is pierced; the sternal portion of the odd interambulacrum is tumid and convex; the

basal portions of the lateral and anterior pairs slope gently towards it; the tracks of the ambulacra are nearly naked as they approach the mouth, and are here perforated with buccal pores. The mouth is at the anterior third, and has a projecting underlip; the tubercles on the upper surface are small and of a uniform size; those on the sternum are larger, and are perforated and set on crenulated summits; they are arranged in lines radiating from a postea point; the tubercles of the interambulacral pairs are the largest.

Affinities and differences.—This species very much resembles the living *S. canaliferus*, but it may be distinguished from it by the following characters:—*S. eurynotus* is broader and more depressed before, and is not proportionally so high behind as *S. canaliferus*; the antero-lateral ambulacra are more divergent, and the postero-lateral pair are proportionally longer in *S. eurynotus* than in *S. canaliferus*. The single ambulacrum is about the same depth as the pairs, and has the pores in a single file in *S. eurynotus*, whereas in *S. canaliferus* this area is much deeper, and the pores are not in single file, but are crowded together, so that they form three rows in a part of the zone; the tubercles of the base are much larger in the living than in the fossil species. *S. eurynotus* is distinguished from *S. Parkinsoni* by its *f*-shaped ambulacra being less divergent, and the position of the apical disc, which is much nearer the posterior border in *S. eurynotus*; the anterior ambulacrum is likewise much wider and deeper in that Urchin than in *S. Parkinsoni*: the great development of the single interambulacrum, and breadth of the posterior border in *S. Desori* sufficiently mark that species as widely distinct from *S. eurynotus*.

Locality and position.—Collected in bed No. 4, the calcareous sandstone at Malta; we have it also from Santa Manza, Corsica, sent us by M. Michelin; it has likewise been found in the Ter. moyen de Perpignan, Cagliari.

Schizaster Desori, Wright, n. sp. Pl. VI. fig. 3 *a-c*.

Test cordate, broad and much depressed before, narrow and much elevated behind; ambulacral areas long, straight, and very divergent; peripetal fasciole forms an acute angle on the anterior interambulacra; apical disc situated at the posterior third of the dorsum; angle of the antero-lateral ambulacra 44° ; angle of the postero-lateral pair 60° ; posterior border truncated obliquely downwards and inwards; sternal portion of the interambulacrum tumid and prominent at the base, amounting almost to a deformity.

Dimensions.—Antero-posterior diameter $2\frac{8}{10}$ inches, transverse diameter $2\frac{7}{10}$ inches, height at the deepest part $1\frac{8}{10}$ inch.

Description.—This remarkable Urchin wants the symmetrical proportions of the other Schizasters met with in the same rocks; it is rounded and broad before, and tapers into a narrow wedge-shape process behind; the dorsal surface inclines forwards at an angle of 17° ; the ambulacral areas are long. The single anterior area compared with *S. eurynotus* is narrow, and of a uniform width; it is $1\frac{5}{10}$ inch in length from the apical disc to the fasciole; there are twenty-four pairs of pores in the avenues, the external being much larger than the internal row, although this is properly speaking a generic character. The antero-lateral ambulacra diverge nearly straight outwards at an angle of 44° ; they form deep depressions in the test $1\frac{5}{10}$ inch in length, and the zones contain thirty pairs of holes in each: the postero-laterals are slightly petaloid, and gently flexed outwards; they are $\frac{1}{2}\frac{5}{6}$ ths of an inch in length, and diverge at an angle of 60° . The zones contain about twenty pairs of holes; the test being nearly as broad as it is long across the termination of the antero-lateral ambulacra; the anterior border is gently rounded, and has a rather deep anteal sulcus for the ambulacrum; from the same point to the posterior extremity it tapers suddenly, which gives a wedge-shaped appearance to the test when viewed from above. The most remarkable feature in this Urchin is the curious form which the single interambulacrum assumes, owing to the great development of this area; the dorsal surface forms an inclined plane having an inclination of 17° ; the anterior part is therefore very much depressed, and the posterior part much elevated. The single interambulacrum forms a prominent beak-like process, beneath which the posterior border is broad, and inclined downwards and forwards; the sternal portion of this area is prominent and convex, towards which the basal parts of the lateral interambulacra slope suddenly forwards and inwards. The anus is pyriform, and placed high up underneath the beak-like process. The mouth is situated near the anterior border; it has a large under-lip, but is crushed in the small specimen, and covered up in all the others before us. The small apical disc lies concealed at the posterior third of the dorsum by the prominent apices of the lateral interambulacra. The peripetal fasciole takes a zigzag course along the outer borders of the ambulacra, and from the base of the antero-laterals it passes nearly at right angles across the anterior interambulacra to the external side of the single ambulacrum, where it makes another angle, then passes down the side thereof $\frac{5}{10}$ ths of an inch, dips into the sulcus and unites with the opposite fasciole. The lateral fasciole commences at the angle near the base of the antero-lateral ambulacra, and passes downwards and backwards nearly in a straight line over the angle of the posterior border at some distance from

the anus, and meets the one from the opposite side, at the middle line near the base; in the triangle thus formed, the caudal process and anus occupy the base, and a depression lies beneath which is filled with tubercles somewhat larger than those on the dorsum, but smaller than those on the base; the tubercles are perforated and raised on prominent crenulated bosses (fig. 3 c); the sternal and basal portions of the test, as well as the anterior border, being furnished with much larger tubercles.

Affinities and differences.—The straightness of the pairs of ambulacra, and the narrowness of the single anterior ambulacrum, are alone sufficient to distinguish *S. Desori* from *S. euryotus* when viewed only from above, but when we add to these the remarkable oblique truncation of the posterior border (fig. 3 b), the great tumidity of the sternum, and the sloping character of the sides of the base, we discover how widely different these two forms are from each other. The same group of characters serves to distinguish it from *S. Parkinsoni*, but in this species the apical disc is much nearer the centre of the test; the antero-lateral ambulacra are arched outwards, and the postero-laterals are proportionately longer.

Locality and stratigraphical position.—Collected from the calcareous sandstone bed No. 4, at Malta; the large specimen belongs to the Bristol Institution, the others form part of Earl Ducie's collection. We dedicate this species to M. Desor of Neuchâtel, one of the learned authors of the 'Catalogue raisonné des Echinides.'

Schizaster Parkinsoni, DeFrance sp. Pl. V. fig. 3 a-c.

SYN. *Spatangus Parkinsoni*, DeFrance, Dict. Sc. Nat. tom. 50. p. 96; Desmoulins, Etudes sur les Echinides, p. 394. no. 29.

Spatangus lacunosus, Parkinson, Organic Remains, vol. iii. tab. 3. fig. 12.

Schizaster Parkinsoni, Agassiz and Desor, Cat. raisonné, Ann. Sc. Nat. tom. viii. p. 22.

Test cordate, depressed anteriorly, elevated posteriorly; apical disc nearly central; sides expanded and tumid; cheeks sloping and contracted; single ambulacrum rather wider than the anterior pair, of the same diameter throughout, except near the apex; antero-lateral ambulacra diverge at an angle of 35° ; length 1 inch; postero-lateral make an angle of 65° ; length $\frac{6}{10}$ ths of an inch; posterior part of the back raised into a long prominent carina; posterior border obliquely truncated; base convex; mouth near the anterior border; antecal sulcus narrow and of moderate depth.

Dimensions. — *Adult.* Antero-posterior diameter $2\frac{1}{2}$ inches, transverse diameter $2\frac{1}{8}$ inches, height $1\frac{1}{8}$ inch.

Junior. Antero-posterior diameter 2 inches, transverse diameter $1\frac{2}{10}$ inch, height $1\frac{5}{10}$ inch.

Description.—We have identified this Urchin with that figured by Parkinson in his 'Organic Remains,' not however without much hesitation, inasmuch as that figure is without details, and is moreover drawn from a distorted specimen. We have in vain endeavoured to find out the original, and have therefore, from the central position of the apical disc and the great divergence of the ambulacra, and from its being at the same time the most common of all the Maltese Schizasters, and the one most likely to have been sent to Parkinson, adopted DeFrance's identification. The test is heart-shaped, its widest part being at a line drawn across the disc; from this imaginary line the back slopes obliquely forwards, and the border is rather bevelled away at the cheeks; from the same line backwards there rises a prominent ridge which bends over into a short tail-like process. The ambulacral areas (3 *a*) are deeply sunken, the single ambulacrum has a tapering lanceolate form, and the anteal sulcus is deep and narrow; the poriferous zones lie in the angle of the depression; they consist of twenty-five pairs of holes, of which the outer series is the largest; the length of the petaloidal portion of this area from the apex to the fasciole is $1\frac{1}{10}$ inch. The antero-lateral ambulacra (3 *a*) are more divergent in this species than in the other Schizasters met with in the same rocks; they are $1\frac{1}{10}$ inch in length and are slightly curved outwards and backwards; they make an angle of 35° ; the number of pores (3 *c*) in the zones is respectively thirty-six and thirty-four, the apical eight pairs being almost microscopic: the postero-lateral pair are $\frac{6}{10}$ ths of an inch in length and slightly *f*-shaped; they are directed backwards at an angle of 65° , and are proportionately narrower than the anterior pair; there are twenty-two pairs of holes in each of the zones, the upper six pairs of which are microscopic. The peripetal fasciole (3 *b*) is distinctly defined and passes close to the bases of the petaloid portions of the ambulacra, but at a short distance from the sides thereof it describes a curve inwards in passing over the anterior interambulacra, and dips obliquely into the anteal sulcus where it unites with that of the opposite side. The lateral fasciole is large and very distinct; it takes a backward and downward course towards the base of the posterior border, and joins its fellow at some distance below the anus; the two fascioles form the letter V in their *trajet* on the test. The apical disc is situated very near the centre of the back, removed a little nearer to the posterior than the anterior border; it is perforated with four equal-sized genital holes. The anus is oblong, situated high up in the obliquely truncated posterior border, in which is a triangular depression limited on

the sides by the fasciole, and above by the anal opening and caudal process; the base is convex; the sternum is not very prominent, and has lines of tubercles proceeding in radii from a point near the border; the basal portions of the posterior ambulacra are naked, and around the mouth buccal pores are seen, which extend at considerable intervals along the *trajet* of the posterior pair. The mouth is situated in the anterior fourth of the base and has a projecting under-lip; the basal parts of the interambulacra glide into the general convexity of the floor of the test; the lateral pair have a regular tuberculation, but on the anterior pair the tubercles are larger and more irregular.

Affinities and differences.—The nearly central position of the apical disc and the greater divergence of the antero-lateral ambulacra distinguish this Urchin from its congeners; the narrowness of the odd ambulacrum and the absence of the swelling-out in the centre of the same, serve to separate it from *S. eurynotus*; the blunt caudal process, the small posterior border, and the general tumidity of the sides distinguish it from *S. Desori*.

Locality and stratigraphical position.—Collected from bed No. 4, the calcareous sandstone at Malta, where it is common; it is found likewise in the Molasse, middle tertiaries, of Martigues, Bouches-du-Rhone. Fine specimens are contained in the British Museum, Jermyn Street Museum, and that of the Bristol Institution.

Since the preceding sheets of this memoir have been passing through the press, we have had the opportunity of examining the Maltese fossils belonging to the Geological Society, and some that had escaped our notice in the British Museum collection; from these new materials the following notes are now added:—

Clypeaster Reidii, Wright, n. sp.

Test large, broadly pentagonal, and much elevated; border abrupt, margin thin and undulated, rising with steep sides at angles of 60° , and with a very little curve towards the vertex, which is nearly central; petaloidal portions of the ambulacral areas large, nearly equal in width, and extending over nearly three-fourths of the sides; base quite flat; mouth small, pentagonal, nearly central; basal ambulacral sulci proceeding from the angles of the mouth, narrow, and sharply defined; anus round, near the posterior margin; tubercles on the upper surface small and closely set together, those on the base a little larger; apical disc nearly central and prominent, with an outer circle of genital holes, and an inner circle of eye-holes having the madreporiform tubercle in the centre.

Dimensions.—Antero-posterior diameter $5\frac{6}{10}$ inches, transverse diameter $5\frac{2}{10}$ inches, height $2\frac{8}{10}$ inches.

Description.—This large *Chypeaster* has been mistaken for one of the varieties of *C. altus*, but a careful study of its test discloses characters by which it is readily distinguished from that common form. The circumference is nearly pentagonal; it is rounded before, undulated on the sides, and nearly straight behind; the sides of the pentagon are of unequal length, those forming the front of the test are the shortest, those of the middle are somewhat longer, and the posterior single side is the longest. There is scarcely any margin to the test in this species, as the sides rise abruptly from the border to the apex, making angles of 60° with the base, and being only slightly curved inwards; the dorsum is therefore very small in proportion to the diameter of the base. The petaloidal portions of the ambulacral areas extend over nearly three-fourths of the sides; they form long elegantly-shaped petals, narrower in proportion to their length than those of *C. altus*, and consequently allowing of a greater development of the interambulacral areas than in that species; the petaloidal ambulacral areas are nearly all of the same length, width and structure; the centre of each petal is arched and costated, and forms a considerable relief on the surface of the test. The poriferous zones lie in slight depressions on their sides; each zone contains sixty-two pairs of pores set widely apart; in the inner row the holes are round, in the outer row they are oblong, and both are united by straight oblique sulci; the external surface of the partition-wall between each pair is covered with a row of small tubercles. The bases of the ambulacra are open, but not so widely as in some other congeneric forms. The interambulacral areas are nearly flat, of moderate width, and very uniform in their structure. The apical disc occupies the centre of the dorsal surface; it consists of two circles of holes; the outer is formed of five small genital holes, the plates of which are not distinguishable, and the inner of five small perforated ocular plates, which are distinctly visible at the apices of the ambulacra. The madreporiform tubercle occupies the centre, and forms a button-like prominence there; the border is thin and undulated, and this portion of the test presents a striking difference to the obtuse marginal fold seen in *C. altus*. The base is quite flat; the pentagonal mouth is small and nearly central; the oral lobes are curved inwards at an acute angle, and the five ambulacral sulci are sharply defined as they radiate from the sides of the pentagon to the border. The anus is round, and is situated near the posterior border: the tubercles on the upper surface are small and closely set together; those on the base are a little larger.

Affinities and differences.—*Chypeaster Reidii* very much resembles *C. umbrella* both as to height, width, and the smallness of its tubercles; it is distinguished from that species by the following characters: *C. Reidii* is more elongated; the petaloidal ambulacra are longer and narrower; the interambulacra are flattened and slightly curved; the base is quite flat, and the oral lobes are curved acutely inwards. In *C. umbrella* the interambulacra are arched and costated, the base is concave, and the oral lobes slope obliquely inwards. Compared with *C. altus*, the differences are found to be still greater: in *C. Reidii* the test is broader in proportion to its length; the petaloid ambulacra are narrower; the poriferous zones are not so open at the base. The apical disc is convex and prominent in *C. Reidii*, and depressed in *C. altus*. In *C. Reidii* the border is thin and sharp, and the base is flat. In *C. altus* the border is thick and rounded, and the base is concave. In *C. Reidii* the mouth is small, and the oral lobes curve acutely inwards; whilst in *C. altus* the large mouth lies at the bottom of a concave depression formed by the gradual inward sloping of the interambulacra. The distinctions between our species and that of *C. scutellatus* and *C. marginatus* are so well defined, that it is unnecessary to make a comparison with them.

Locality and stratigraphical position.—This species is apparently from bed No. 1, the Gozo marble, but this we cannot with certainty state. Fine specimens are in the Jermyn Street Museum, and in the collection of the Geological Society of London. We dedicate this species to his Excellency Sir William Reid, Governor of Malta, whose laudable efforts to form a public collection of Maltese fossils have greatly contributed to our knowledge of the palæontology of the island.

Genus PYGORHYNCHUS, Agassiz, 1839.

In the dismemberment of the genus *Nucleolites* of Lamarck, M. Agassiz has not been so fortunate as in other groups of *Echinida*: the characters on which, for example, *Catopygus* and *Pygorhynchus* are distinguished from *Nucleolites* are not satisfactory, as they undergo important modifications in the different species grouped together in each of these new genera. If we take a type specimen of each genus only and compare them together, we admit the distinctions pointed out; but when we examine several species of each of these genera, we observe the characters gradually blending into the primary type form: as representatives in time, the grouping is valuable, but the zoological characters in our judgment are too indefinite to found genera thereon. With these remarks we refer provisionally the

small Nucleolite before us to the section *Pygorhynchus*, which is thus characterized by Agassiz :—"Form elongated; ambulacra distinctly petaloid, often costated as in *Echinolampas*. Mouth central or subcentral, pentagonal, surrounded with five large lobes, and a distinct rosette of buccal pores. Anus posterior, nearer the superior than the inferior border." All the species of the genus *Pygorhynchus* belong to the nummulitic and tertiary rocks; those of the genus *Catopygus*, with one exception, are cretaceous forms.

Pygorhynchus Vassalli, Wright, n. sp.

Test oblong, wider behind than before; interambulacrum produced into a caudal elongation; petaloid portions of the ambulacral areas narrow and short; sides tumid; anus small, round, nearer the inferior border than the dorsum, with a projecting beak-like process arching over its upper border, and an oblique truncature of the lower part of the border below; base slightly concave; mouth pentagonal, nearly central; oral lobes small; rays of the poriferous star around the margin short.

Dimensions.—Antero-posterior diameter $1\frac{3}{10}$ inch, transverse diameter $\frac{7}{10}$ ths of an inch, height nearly $\frac{6}{10}$ ths of an inch. Most of the specimens average only from one-half to two-thirds of these dimensions. The large specimen before us is the most perfect we have examined.

Description.—This small Urchin has an oblong form; it is rounded before, a little enlarged towards the junction of the middle with the posterior third, which is produced into a caudal process. The sides are tumid, and the upper surface is flattened; the petaloid portions of the ambulacral areas are narrow and short, and form only a star on the dorsum; the single and postero-lateral areas are nearly alike in width and length; the antero-lateral pair are rather wider and shorter, they are $\frac{7}{10}$ ths of an inch in length, and are slightly curved forwards and outwards; their poriferous zones contain eighteen pairs of pores, arranged in narrow rows, and not united by any apparent slit. The postero-lateral areas are $\frac{3}{10}$ ths of an inch in length, and their zones contain twenty pairs of pores; these areas are directed much backwards, which makes the width of the lateral interambulacra proportionally greater. The apical disc is nearly central, but nearer the anterior border; it has four large genital pores, and five well-marked eye-holes. The single ambulacrum is almost identical in length and width with the posterior pair; the apices of all the ambulacra are rather rounded than lanceolate. The lateral interambulacra we have said are very wide, but the single

interambulacrum is narrow, and forms a conspicuous prolongation or beak-like process, which arches over the upper border of the round anal opening, situated rather below the middle of the posterior border, in an oblique truncature of the test: this beak-like process is not seen in the small specimens before us; it would therefore appear to be a character of the adult condition only. The base is slightly concave towards the mouth, which is situated nearer the anterior border; it has a pentagonal form, with five small oral lobes covered with tubercles; between them, the terminations of the ambulacra form five short poriferous petals. The tubercles on the upper surface are small and irregularly disposed on the plates; those on the base are a little larger, especially in the vicinity of the mouth.

Affinities and differences.—This species resembles *Catopygus fenestratus* from the upper chalk of Ciply, Belgium, but is distinguished from it by having the sides more tumid and the upper surface flatter; the posterior border is likewise more produced; it distinctly differs from it however in having the base slightly concave, and the oral lobes less developed. It differs from *Nucleolites* (*Pygorhynchus*) *subcarinatus*, Goldf., from the middle tertiaries of Bünde, in having more tumid sides, a less concave base, and a different form of the anal opening. From the very brief notice of *Catopygus conformis*, Desor, from the tertiaries of Orglande, it is impossible to form any idea how far it may resemble that form, as it is neither figured nor described, but merely entered in the 'Catalogue raisonné' with this remark: "Mais l'anus est un peu plus bas, et la face supérieure plus surbaissée."

Locality and stratigraphical position.—Collected from bed No. 1, Malta, where it is extremely rare. Specimens are in the collection of the Geological Society, the Jermyn Street Museum, and the cabinet of Earl Ducie. We dedicate this species to Dr. Vassallo of Malta, under whose judicious care and continued research the public collection of Maltese fossils has been greatly enriched.

Spatangus Desmarestii, Goldf.

SYN. *Spatangus Desmarestii*, Goldf. Petref. p. 153. tab. 47. fig. 4 a-c; Agassiz and Desor, Cat. raisonné, Ann. Sc. Nat. tom. viii. p. 7.

Test cordate, arched and carinated; anteal sulcus broad; petaloid portion of the antero-lateral ambulacra long, narrow, and curved outwards and a little backwards, angle of inclination 18° ; postero-laterals long and narrow, angle 60° ; only a few moderate-sized tubercles on the interambulacral plates between all the ambulacral areas; border slightly obtuse; posterior part truncated; anal opening transversely oblong; base plano-

convex; tubercles moderate in size; mouth transversely oblong, situated at the junction of the anterior with the middle third; tubercles on the upper surface very small.

Dimensions.—A German type specimen. Antero-posterior diameter $2\frac{7}{10}$ inches, transverse diameter $2\frac{6}{10}$ inches, height $1\frac{9}{10}$ inch.

A Maltese specimen. Antero-posterior diameter $1\frac{8}{10}$ inch, transverse diameter $1\frac{7}{10}$ inch, height $\frac{1}{2}$ ths of an inch.

Description.—This Urchin is well known from the admirable figure in Goldfuss. Its upper surface is more convex and inflated than in the other congeneric species; it is higher behind than before, and has a blunt ridge which passes backwards from the disc to the border. The antero-lateral petaloidal ambulacra, $\frac{1}{2}$ ths of an inch in length, curve a little outwards, forming an angle of 18° ; their zones contain from twenty-two to twenty-four pairs of pores, separated by rather thick partitions of the test. The postero-lateral areas are narrower than the anterior pair, and rather more than an inch in length; their zones contain from twenty-eight to thirty pairs of holes, and they form angles of 60° . The interambulacral areas are wide and largely developed in this species; the upper plates in these areas, lying between the ambulacra, support only very small perforated tubercles, arranged in groups of threes and fours, and disposed on all the areas; this character serves to distinguish *S. Desmarestii* from all its congeners at present known: the small tubercles on the dorsal surface are very small, and closely set together. The single ambulacrum is lodged in a broad shallow valley, which forms however a considerable anteal sulcus; the pores in this area are so much covered up with matrix in our specimen, that we are unable to count their number. The posterior border is truncated, and the large transversely oval anal opening occupies the upper part of this region. The shelly matrix entirely conceals the course of the subanal fasciole. The sternal portion of the interambulacrum is slightly convex, and covered with small tubercles that radiate in lines in all directions from a central point; the basal portions of the anterior and lateral interambulacra are covered with larger tubercles, and the naked intermediate spaces indicate the *trajet* of the basal portions of the postero-lateral ambulacra from the border to the mouth. The mouth is situated at the junction of the anterior with the middle third; it is much elongated transversely, and has five poriferous petals surrounding it. The apical disc is small and nearly central; it has four genital holes and five small eye-holes.

Affinities and differences.—The inflation of the test, the small-

ness of the large tubercles on the upper surface, and their presence on the interambulacrum, serve to distinguish this species from its congeners.

Locality and stratigraphical position.—Found with *S. Hofmanni* in bed No. 4, the calcareous sandstone at Malta, where it is rare. The Maltese specimens we have seen are small, and do not exceed the dimensions given; they are contained in the collections of the British Museum and the Geological Society. In Germany it is found in the middle tertiaries at "Duberger bei Bünde, and at Astrupp bei Osnabrück." The admirable figure given by Goldfuss of this species is all that can be desired.

Genus *EUPATAGUS*, Agassiz, 1847.

Spatangoid Urchins, with a cordate or elliptical form, more or less depressed; the petaloid portions of the antero- and postero-lateral ambulacral areas are wide; the single area is lodged in a shallow antea sulcus, and the entire ambulacral star is closely surrounded by a broad well-defined peripetal fasciole, which undulates round its margin; within this fasciolar space, the interambulacral plates carry very large perforated tubercles raised on crenulated bosses, and surrounded by wide smooth areolas, like those in the genus *Spatangus*. The heart-shaped shield, beneath the anal opening, is likewise surrounded by a well-defined subanal fasciole. The basal portions of the postero-lateral ambulacra form broad, naked bands, between the posterior border and the mouth. The other characters resemble those of *Spatangus*, from which it differs however in possessing a *peripetal fasciole*.

Eupatagus De Koninckii, Wright, n. sp.

SYN. *Spatangus De Koninckii*, Wright, Ann. of Nat. Hist. vol. xv. p. 178.

The test of the original specimen of *Eupatagus De Koninckii* having had the external layer of its shell and consequently its fascioles denuded, we are now enabled to correct our determination of this species from a specimen in the collection of the British Museum, in which these important parts of the anatomy of the skeleton are well preserved. For the description of this Urchin see our article *Spatangus De Koninckii*, to which we subjoin the following note:—The peripetal fasciole is rather broad, surrounding with little undulation the ambulacral star, and forming a well-defined boundary between that portion of the upper surface with large perforated tubercles, and that part with very small tubercles; the subanal fasciole heart-shaped, rather broad, and enclosing a shield-like space filled with larger

tubercles; it extends from the prominent point of the base to near the lower part of the anal opening.

Scalaria Duciei, Wright, n. sp. Pl. VII. fig. 4 a, b.

Diagnosis.—Shell turriculated, imperforate; spire gently tapering; whorls ten, with transverse prominent plates and longitudinal elevations. The transverse plates, nineteen in number on the body-whorl, are formed of numerous thin shelly laminae, closely united where they proceed from the whorl, but outwardly they expand and form a rather irregular undulated surface; each plate describes three curves; two of these, the anterior and posterior, are short, and the central one is long, forming an arch over the whorl; the posterior, at their junction with the central curve, form angles, from whence blunt spiny processes proceed; these form a conspicuous ridge on the posterior upper part of the whorls; the junction of the anterior with the central curves forms a carina on the body-whorl, which commences at the posterior border of the aperture, and terminates at the anterior part thereof, at a distance from the umbilical ridge. The longitudinal elevations form a kind of cellular structure; between the plates they are seven or eight in number, and on them and the intervening surface of the shell, delicate longitudinal lines are sculptured. The aperture is entire, and is round or inclining to an oblong.

Dimensions.—Length $2\frac{2}{10}$ inches, diameter of the body-whorl $\frac{1}{2}$ ths of an inch.

Collected from the calcareous sandstone No. 4, at Malta.

Lenticulites complanatus, DeFrance. Pl. VII. fig. 4 a, b.

Genus LENTICULITES, Lamarck. (Subkingdom *Radiata*. Class *Foraminifera*. Order *Hélicostègues*, D'Orb. Family *Nautiloidæ*.)—Shell nautiloid, equilateral, spire rolled on the same plane, compressed, sublenticular, multilocular; whorls apparent, opening narrow, triangular, prominent, against the penultimate turn of the spire.

Diagnosis.—Shell oblong, lenticular, much compressed; septa convex, with longitudinal partitions, growth lines very apparent. Long diameter $\frac{4}{10}$ ths of an inch.

This beautiful Foraminiferous shell occurs in great abundance in No. 2, the yellow sand with blackish grains; in fact it forms large masses of rock in this bed. As it is constantly associated with the Echinoderms, we have added a drawing thereof. DeFrance noticed, but did not figure this fossil; he collected it at "Anvers près de Pontoise, à Dax, à Loignan près de Bordeaux,

à Boutonnet près de Montpellier, et en Italie dans les couches, qui paroissent appartenir au calcaire coquillier grossier*."

EXPLANATION OF PLATES IV. V. VI. AND VII.

PLATE IV.

- Fig. 1.** *Cidaris Melitensis*: *a*, the upper surface; *b*, side view of the ambulacral and interambulacral areas, natural size; *c*, an interambulacral plate, and a portion of an ambulacral area with the poriferous zones, magnified.
- Fig. 2.** *Echinus Duciei*: *a*, upper surface; *b*, side view, natural size; *c*, the form of the mouth-opening, showing the disposition of the marginal notches; *d*, the five jaws and teeth "*in situ*," imbedded in a mass of rock; *e*, the apical disc, showing the arrangement of the genital and ocular plates; *f*, two interambulacral plates, and a portion of a poriferous zone, magnified.
- Fig. 3.** *Echinolampas Deshayesi*: *a*, the upper surface; *b*, the under surface, natural size; *c*, a portion of the test, showing the tubercles, magnified; *d*, a portion of an ambulacral area, and poriferous zones, magnified.

PLATE V.

- Fig. 1.** *Brissus latus*: *a*, the dorsal surface, reduced one-third in size; *b*, the apical disc, magnified; *c*, the perforated tubercles, with their crenulated bosses and encircling granules, magnified.
- Fig. 2.** *Brissus oblongus*: *a*, the upper surface, showing the petaloid ambulacral star and peripetal fasciole; *b*, the under surface, showing the subanal fasciole, natural size; mouth, and the *trajet* of the naked basal portions of the ambulacra; *c*, the tubercles, and their circles of granules, magnified.
- Fig. 3.** *Schizaster Parkinsoni*: *a*, the upper surface, showing the petaloid ambulacral star, the peripetal and lateral fascioles, the natural size; *b*, a portion of the peripetal fasciole, with the boundary granules, magnified; *c*, a portion of the poriferous zones, magnified.

PLATE VI.

- Fig. 1.** *Brissopsis Duciei*: *a*, the upper surface, showing the petaloidal ambulacral star, surrounded by the peripetal fasciole, reduced one-third; *b*, six plates with small poriferous tubercles from the antea sulcus; *c*, form of the pores, and arrangement of the tubercles in the poriferous zones; *d*, the larger perforated tubercles, and their crenulated bosses with their circlets of granules; *e*, a portion of the peripetal fasciole, showing how distinctly it is defined from the rest of the surface by rows of granules.
- Fig. 2.** *Brissopsis crescenticus*: *a*, the upper surface; *b*, the under surface, natural size; *c*, the arrangement of the pores, near the apical portion of one of the zones.
- Fig. 3.** *Schizaster Desori*: *a*, the upper surface; *b*, the under surface, natural size; *c*, the perforated tubercles, with their circlets of granules and crenulated bosses, magnified.

* Dict. Sc. Nat. tome xxv. p. 453.

PLATE VII.

- Fig. 1. *Hemiaster Scilla*:** *a*, the upper surface, showing the ambulacral star and peripetal fasciole, natural size; *b*, the under surface of the same test; *c*, a lateral view, to show the great height of this species; *d*, the perforated tubercles and encircling granules, magnified; *e*, a portion of the single ambulacrum, showing the arrangement of the pores; *f*, a portion of a poriferous zone.
- Fig. 2. *Hemiaster Cotteauis*:** *a*, the upper surface, natural size; *b*, the perforated tubercles, with their circles of granules; *c*, portion of a poriferous zone; *d*, portion of the peripetal fasciole, with its boundary granules.
- Fig. 3. *Scalaria Duciei*:** *a*, shell, the natural size; *b*, a fragment showing the mouth.
- Fig. 4. *Lenticulites complanatus*:** *a*, natural size of this Foraminiferous shell; *b*, a section magnified, showing the cells:—large rocky masses of this fossil occur in the yellow sand associated with the Urchins of that deposit.

On *Perna quadrata*, Sow. By JOHN LYCETT, Esq.

READ 30TH JANUARY 1855.

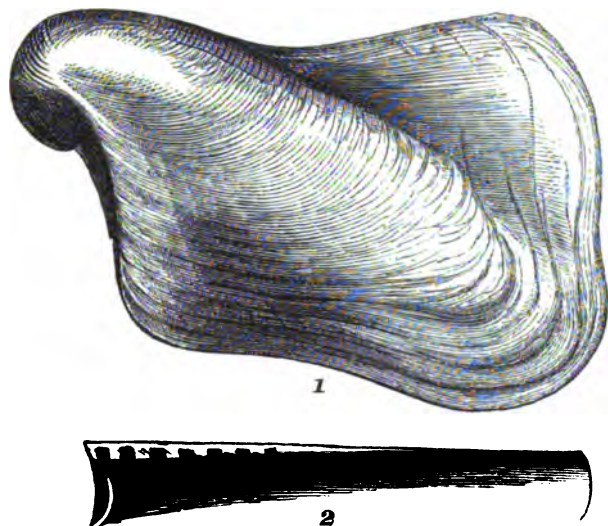
THE present notice of a fossil shell, which has already been figured and described, requires some explanation.

The *Perna quadrata* of the 'Mineral Conchology,' t. 490. f. 2, represents a very inequivalve *Perna*; but as the specimen figured appears to have been somewhat imperfect, and as it was placed by the artist in an unfortunate position and is seen only from a single point of view, it affords a very insufficient aid to a description which is substantially correct as far as it refers to the only specimen which appears to have been at the disposal of the author. With such an illustration it will not afford surprise to find that Phillips in his Geology of Yorkshire, t. 9. f. 24, represented a second and very different shell under the name of *Perna quadrata*; and as the latter work contains no descriptions of species, Goldfuss was in turn also misled to figure a third *Perna* distinct from both the others under the same name (*Petrefacta*, t. 108); upon the same plate however is *Perna rugosa*, which is identical with the *quadrata* of Phillips; the latter is an equivalve, squamous, thick shell, well known to collectors of British Inferior Oolite fossils. There is another inducement to acquire a correct knowledge of the original *Perna quadrata*, inasmuch as the species is a very remarkable one, constituting a departure from the typical forms of the *Pernæ*, and approaching to others of the kindred genus *Inoceramus*. The diagnosis of this shell in the 'Mineral Conchology' is as follows:—"Quadrilateral, one side shorter than the other three; valves gibbose, unequal, the shorter side very concave, bounded by two obtuse carinæ."

The figure in the 'Mineral Conchology' has the right or flattened valve facing the spectator; the contour of the larger or convex valve therefore is not seen: the shell is not placed upright upon the page, the lower border forming the right-hand side of the figure: even the outline is not perfect, as there seems to be a portion of the lower border wanting, and thus forming an angle at its anterior extremity, which would be rounded were that part entire.

The typical *Pernæ* are equivalve or subequivalve; their fibrous tests are squamous externally, and acquire great thickness with

advance of growth; the valves are so much flattened, that their attenuated apical extremities have not more thickness or convexity than the corresponding parts of the *Pinna* and *Mytili*; the hinge-plate is always broad, the greater length of the valve being always perpendicular to, or in the opposite direction to the line of the hinge-plate. *Perna quadrata*, on the contrary, is very inequivalve, and with advance of growth it becomes almost gryphoidal; the umbo of the larger valve is very prominent, straight and incurved; the anterior side of the valve is steep, with a large excavation, byssal aperture and corrugated border; the posterior side is much compressed, and extended into a kind of imperfect wing; the hinge-plate is narrow, its border is much lengthened, so that the greater length of the valve is in



Perna quadrata, Sow.

1. Exterior of the convex valve. 2. Hinge-plate of the flattened valve.
(Reduced one-fourth.)

that direction, and the shell is transverse; the narrow hinge-plate renders the ligamental grooves very short, their diameter laterally being equal to their length, as is often seen in the genus *Gervillia*; they diminish rapidly, so that the posterior half of the hinge-line is destitute of hinge-plate and grooves. The byssal aperture is formed by the larger valve only. In both valves the test is very thin, excepting at the prominent umbo and anterior side of the larger valve; the surface, unlike that of the typical *Pernæ*, is smooth; the right valve has little convexity, and its umbo little prominence; its anterior border is thickened as in the other valve.

In the *Pernæ*, as in the *Inocerami*, much variability exists in

specimens of the same species, the result not only of different stages of growth, but also of individual peculiarities. All the specimens of *Perna quadrata* differ more or less from each other and from the figure in the 'Mineral Conchology,' so that the identity of these specimens with Sowerby's shell has not been ascertained without the examination of a considerable number of examples. The contrast which *Perna quadrata* presents to the typical *Perne* is therefore very great; its general aspect is in fact that of an *Inoceramus*, more especially of the subinvolute forms of the latter genus, from which it is distinguished only by the anterior excavation and aperture; but as this feature is one only of subordinate value when viewed singly, there would seem to need the addition of some other distinctive features ere we are enabled to affirm the clear generic separation of *Perna* and *Inoceramus*. The oblong flattened figure of the smaller valve and the thinness of the test might cause it to be mistaken for a *Crenatula* when the hinge-plate is not exposed. *Perna quadrata* may therefore be regarded as the type of a group of inequivalve transverse shells, whose relation to the typical *Perne* may be compared with that which certain aberrant species of the kindred genera *Inoceramus* and *Gervillia* bear to their respective typical groups. Of the Jurassic forms may be instanced the large *Gervillia Hartmanni* and *G. tortuosa*, compared with the flattened sub-equivalve species of the same genus; in these and other instances the inequality of the valves becomes more marked with advance of growth. The very perfect preservation of the hinge-plate, together with the condition of the tests of associated bivalves, forbids the supposition that the thinness of the test has been produced by the removal of thick nacreous layers from the inner surface.

Dimensions.—Length of our largest specimen in the direction of the hinge-line $5\frac{1}{4}$ inches, height $3\frac{1}{4}$ inches, convexity of the larger valve 2 inches.

Geological position and localities.—The specimen figured in the 'Mineral Conchology' is from the Cornbrash of Bulwick; our own specimens are from the freestone portion of the Inferior Oolite near Nailsworth, from a quarry in Woodchester Park, worked for the purposes of the Roman Catholic Monastery; specimens have also been obtained in the freestone quarries of Scar Hill in the parish of Minchinhampton, thus affording an additional instance of that general resemblance between the Testacea of the Cornbrash and the Inferior Oolite, which has been noticed by Prof. Buckman in a paper on the Cornbrash of Cirencester, and which forms a part of the Proceedings of the Cotteswold Naturalists' Club. The exact position of *Perna quadrata* in the freestone is the two uppermost beds of that rock, immediately underlying the Oolite marl, or in its absence, the cream-coloured hard argillaceous limestone with *Nerineas* which replaces it in the valley of Nailsworth.

On a New Genus of Fossil Cidaridæ, with a Synopsis of the Species included therein. By THOMAS WRIGHT, M.D., F.R.S.E.

NOTWITHSTANDING the many new generic sections introduced into the classification of Echinoderms, by MM. Agassiz and Desor, and the important light thrown by these savans on our knowledge of the numerous species of this class contained in European collections, still the progress of discovery renders it imperative on palæontologists to modify from time to time many of the opinions put forward by these authors in their 'Catalogue raisonné.' When the amount of real work done by them is taken into account, in a field which was then comparatively unknown, the wonder is, not that mistakes or oversights should have been committed, but that so much good work under the circumstances should have been attained, which will bear the most severe criticism, and remain as it was left, a monument of the genius and industry of the authors.

In our memoirs on the Cidaridæ of the Oolites, we have figured and described three species, *Goniopygus perforatus*, *Pedina Etheridgii* and *Pedina Bakeri*; the true generic position of these forms seemed to us uncertain at the time our papers were passing through the press, as they exhibited characters which did not assimilate with either of the generic divisions of the 'Catalogue raisonné.' Our materials did not then justify us in proposing a separate genus for their reception; the discovery, however, of an interesting series of new congeneric forms has now enabled us to rectify our determination, and propose the genus *Hemipedina* for the group, to which we have added a synopsis of the species included therein.

HEMIPEDINA, Wright, 1855.

This new genus is composed of small, neat, and highly ornamented Urchins, much depressed on their upper surface, and with a flat or slightly concave base. The ambulacral areas are narrow and straight; the pores in the poriferous zones are arranged in single pairs; the interambulacral areas are in general more than double the width of the ambulacral, with two, four, or six rows of tubercles in general arranged abreast on the same tubercular plate. The tubercles are perforated, and set on mammillary eminences with smooth uncrenulated summits; one row of tubercles in general only extends from the peristome to the disc; the other rows, when there are four and six rows in the

area, stop short at the equator, or between the equator and the disc; the intertubercular space on the upper surface of the test is therefore in general wide, and covered with a small miliary granulation. The apical disc is large; the genital and ocular plates are expanded and foliated. The mouth-opening is of moderate dimensions, and the peristome is divided into ten nearly equal-sized lobes. The spines are long, slender, and needle-shaped; those that are known, equal at least the diameter of the test, and their surface is sculptured with delicate longitudinal lines.

Hemipedina is related to *Diadema* in having the pores arranged in the zones in single pairs and the tubercles perforated; but it is distinguished from *Diadema* by the absence of crenulations on the summits of the mammillary eminences. It is related to *Pedina* in possessing perforated and uncrenulated tubercles; but it is distinguished from that genus in having the pores in the zones in single pairs (*Pedina* having the pores in triple oblique pairs like *Echinus*), in having the elements of the apical disc more largely developed, and in the species being nearly all small and depressed forms. *Hemipedina* is related to *Echinopsis* in possessing uncrenulated and perforated tubercles, with the pores in pairs; but it is distinguished from the latter by the narrowness of the ambulacral areas, the depressed form of the test (*Echinopsis* being high and inflated), the form of the mouth-opening, and the deep decagonal lobes of the peristome (that of *Echinopsis* being almost deprived of these incisions), together with the greater size and development of the elements of the apical disc.

Hemipedina, as far as we at present know, is composed of Jurassic species, which commence in the lower Lias and extend into the Coral Rag, each stage possessing its own specific forms. The following synopsis of the British species now before us will be figured and described in detail in our Monograph on the British Oolitic Cidaridæ.

A. Species from the Lias.

Hemipedina Bechei, Wright.

Cidaris Bechei, Broderip, Geol. Proc. ii. 202.

Diadema Bechei, Agassiz, Morris's Catalogue of British Fossils, 1st ed. p. 51.

Test small, much crushed, and covered over with spines; ambulacra with two rows of tubercles; interambulacra with four or six rows of tubercles; spines long, slender and needle-shaped, $\frac{2}{10}$ ths of an inch in length, with longitudinal lines on

the surface. This appears to be identical with the type-specimen in the Museum of the Geological Society.

Locality.—Lower Lias, Lyme Regis.

Coll. J. S. Bowerbank, Esq.

Hemipedina Bowerbankii, Wright, nov. sp.

Test crushed, $1\frac{1}{8}$ th of an inch in diameter; ambulacral areas narrow, with two rows of marginal tubercles rather smaller than those in the interambulacra, a tubercle on every alternate plate; interambulacral areas wide, with six rows of tubercles abreast, surrounded by a delicate scrobicular circle; spines shorter and thicker ($\frac{1}{4}$ ths of an inch in length) than those of *H. Bechei*, although the test is much larger, deeply sculptured with longitudinal lines.

Locality.—Lower Lias, Lyme Regis.

Coll. J. S. Bowerbank, Esq.

Hemipedina Jardinii, Wright, nov. sp.

Test small, much depressed; ambulacral areas wide, with two rows of marginal tubercles which extend from the peristome to the disc; interambulacral areas with two rows of tubercles set near the poriferous zones, from eleven to twelve tubercles in each row, a delicate scrobicular circle of granules around each, and a naked intertubercular space in the centre; mouth-opening small, situated in a depression; peristome decagonal; base finely radiated in consequence of the size and regularity of the interambulacral tubercles.

Locality.—Marlstone near Ilminster, Somersetshire, and Breton Hill, Gloucestershire.

Coll. of the late H. Strickland, Esq., and Dr. Wright.

Hemipedina Etheridgii, Wright.

Pedina Etheridgii, Wright, Annals of Nat. Hist. S. 2. vol. xiii. p. 315. pl. 1. fig. 5 a-d.

Test small, circular, depressed; ambulacral areas narrow, with six small perforate tubercles below, and a double row of marginal granules above; interambulacral areas with two rows of tubercles, seven in each row; apical disc large and petaloidal; mouth-opening small; peristome decagonal; lobes nearly equal.

Locality.—Upper Lias, Ilminster.

Coll. Dr. Wright.

B. *Species from the Inferior Oolite.*

Hemipedina Bakeri, Wright.

Pedina Bakeri, Wright, Annals of Nat. Hist. S. 2. vol. xiii. p. 312.
pl. 1. fig. 4 a-c.

Test circular, depressed; ambulacral areas very narrow, with two rows of small tubercles set so far apart that they form a zig-zag row; interambulacral areas with two rows of rather large prominent tubercles, five in a row; apical disc with a prominent anal rim; mouth-opening large; peristome deeply decagonal.

Locality.—Pea-grit, Inferior Oolite, Crickley Hill.

Coll. Dr. Wright: a single specimen.

Hemipedina perforata, Wright.

Goniopygus? perforatus, Wright, Annals of Nat. Hist. S. 2. vol. viii.
p. 267. pl. 6. fig. 5 a-b.

Test small, circular and depressed; ambulacral areas with two rows of small tubercles which extend from the peristome to the disc; interambulacral areas with two rows of tubercles, seven to eight in each row, three or four secondary tubercles between the primary rows at the base; surface of the plates covered with numerous coarse miliary granules; mouth-opening large; peristome rather deeply decagonal; lobes nearly equal in size; apical disc large and foliated.

Locality.—Pea-grit, Inferior Oolite, Crickley Hill.

Coll. Dr. Wright.

Hemipedina tetragramma, Wright, nov. sp.

Test circular, $\frac{2}{10}$ ths of an inch in diameter; ambulacral areas narrow, with two marginal rows of small nearly equal-sized tubercles extending from the peristome to the disc; interambulacral areas with two rows of primary tubercles, about fourteen in each row, and two rows of secondary tubercles, ten in each row, extending from the peristome to nearly the upper surface; mouth-opening small, situated in a depression; peristome decagonal, unequally lobed.

Locality.—Pea-grit, Crickley Hill.

Coll. Dr. Wright.

Hemipedina Waterhousei, Wright, nov. sp.

Test small, pentagonal, rather inflated at the sides; ambulacral areas with two rows of small tubercles extending from the peristome to the disc; interambulacral areas with two rows of

tubercles, eight in a row ; scrobicular circles neatly defined ; mouth-opening small ; apical disc narrow and prominent.

Locality.—Pea-grit, Inferior Oolite, Crickley Hill.

Coll. Dr. Wright.

Hemipedina Bonei, Wright, nov. sp.

Test small, pentagonal, depressed ; ambulacral areas with two marginal rows of close-set tubercles ; interambulacral areas with one entire row and four short rows of tubercles, which extend only as far as the equator ; tubercles of both areas about the same size ; base flat ; mouth moderate in dimensions ; peristome unequally decagonal ; apical disc absent.

Locality.—Pea-grit, Crickley Hill.

Coll. Dr. Wright.

C. Species from the Great Oolite and Cornbrash.

Hemipedina Davidsoni, nov. sp.

Test much depressed, 1 inch in diameter ; ambulacral areas with two rows of marginal tubercles very regular in their arrangement throughout ; interambulacral areas wide, with two rows of primary tubercles, fourteen in a row, and two rows of secondary tubercles which extend beyond the equator, between the former, and two rows of smaller tubercles between the main rows and the poriferous zones, so that at the equator there are six rows of tubercles abreast, whilst on the upper surface there are only two rows ; mouth-opening small, in a concave depression ; peristome decagonal and nearly equally lobed ; apical disc absent.

Locality.—The sandy beds of the Great Oolite, Minchinhampton.

Coll. Dr. Wright : only one specimen known.

Hemipedina Woodwardii, Wright, nov. sp.

Test circular, much depressed ; ambulacral areas narrow, with two rows of small tubercles below and extending as far as the equator, diminishing to granules on the upper part of the areas ; interambulacral areas with two rows of rather large primary tubercles, eight in a row, and two rows of secondary tubercles, three to four in each row, which scarcely reach the equator, the upper part of the intertubercular space being filled with a small, abundant miliary granulation ; apical disc

large, anal rim prominent ; mouth-opening small ; peristome decagonal, nearly equal-lobed.

Locality.—Cornbrash, Wiltshire.

Coll. British Museum, from Dr. Smith's collection ; Dr. Wright.

Hemipedina tuberculosa, Wright, nov. sp.

Test elevated, subconoidal ?, the precise form unknown ; ambulacral areas with two rows of basal semitubercles raised on very prominent bosses diminishing rapidly in size into coarse granules above ; interambulacral areas with two rows of large tubercles set on very prominent bosses, with scrobicular circles of coarse granules surrounding the areolas ; two rows of small secondary tubercles close to the poriferous zones from the peristome to the equator, and three or four at the base of the intertubercular space ; upper surface enveloped in the matrix ; apical aperture large.

Locality.—Coral Rag, Wiltshire.

Coll. British Museum.

Foreign Species of the genus Hemipedina.

Hemipedina seriale, Wright.

Diadema seriale, Agassiz ; Leymerie, Mém. de la Société Géologique de France, tome ii. p. 330. pl. 24. fig. 1, 1839 ; Agassiz and Desor's Cat. raisonné des Echinides, 3 sér. tome vi. p. 348.

Test hemispherical, subglobose above, flat below ; ambulacral areas with two rows of tubercles nearly as large as those of the interambulacra ; interambulacral areas with six rows of tubercles abreast at the equator, diminishing to four and two rows above ; a few secondary tubercles unequally distributed ; mouth-opening small ; peristome slightly decagonal.

Locality.—Inferior Lias, France.

Coll. M. Michelin.

Hemipedina Woodwardii, Wright.

This species occurs in the Cornbrash of the Marquise, near Boulogne-sur-Mer. In one of the specimens before us the spines are preserved ; the primary spines are not very long, scarcely the length of the diameter of the test ; the secondary spines are short and needle-shaped ; the surface of both kinds is covered with fine longitudinal lines.

Locality.—The Cornbrash near Boulogne-sur-Mer.

Coll. British Museum.

Hemipedina Nattheimense, Wright.

Echinopsis Nattheimense, Quenstedt, Handbuch der Petrefactenkunde, p. 582. pl. 49. fig. 37.

Locality.—White Jura, Nattheim.

Coll. British Museum. At this moment the specimen is not at our disposal. We shall give a diagnosis of this species in our Monograph.

Hemipedina Sæmanni, Wright, nov. sp.

Test small, hemispherical; ambulacra with two rows of tubercles; interambulacral areas with one row of primary and two rows of secondary tubercles, the primary tubercles alternating with the secondary tubercles, not placed abreast as in most of the species; tubercles of both areas nearly the same size.

Locality.—Coral Rag, Commercy, Meuse.

Coll. Dr. Wright: sent by M. Louis Sæmann of Paris.

On some new Species of Hemipedina from the Oolites.

By THOMAS WRIGHT, M.D., F.R.S.E.

SINCE the publication of our paper in the August Number of the 'Annals and Magazine of Natural History,' on the new genus *Hemipedina* and the Synopsis of the species included therein, our friend S. P. Woodward, Esq., has kindly sent us three new English forms of this group, one found in the calcareous grit of Berkshire, and two in the Kimmeridge clay of Bucks; our friend Thomas Davidson, Esq., has likewise communicated a figure of one found by M. Bouchard Chantereaux some years ago in the Kimmeridge clay of Boulogne-sur-Mer; we lose no time therefore in recording these additions to the Oolitic fauna, at the same time returning our hearty thanks to the kind friends who have so liberally communicated the specimens.

A. Species from the Calcareous Grit.

Hemipedina Marchamensis, Wright, nov. sp.

Test large, and depressed; ambulacral areas narrow, with two rows of marginal tubercles, nearly as large as those of the interambulacra, extending regularly and without interruption from the peristome to the apical disc, and separated by a zig-zag line of small granules down the centre, the areas retaining a nearly uniform width throughout; poriferous zones form a slightly waved line, from every three pairs of pores being set slightly oblique to the line of the zones; interambulacral areas four times the width of the ambulacral, with eight rows of tubercles at the equator, each tubercular plate supporting four nearly equal-sized tubercles abreast; bosses prominent; areolas surrounded with incomplete circlets of small granules; mouth-opening less than one-third the diameter of the test; peristome unequally decagonal; five jaws, *in situ*, each jaw having two broad flat central ridges, and two oblique marginal ridges with two intervening depressions; teeth long, and obliquely truncated at the points.

Dimensions.—Transverse diameter $2\frac{2}{10}$ inches; height $1\frac{3}{10}$ inch?

Locality.—The calcareous grit of Marcham, Berks.

Coll. The Hon. R. Marsham.

B. Species from the Kimmeridge Clay.

Hemipedina Morrisii, Wright, nov. sp.

Form and size unknown; test small; ambulacral areas with two rows of regular prominent marginal tubercles gradually diminishing in size from the base to the apex of the areas, and separated by a zigzag line of small granules down the centre; poriferous zones slightly waved; pores large, the pairs separated by thin septa; interambulacral areas more than three times the width of the ambulacral, with six rows of tubercles at the equator, each plate supporting three nearly equal-sized tubercles abreast; bosses prominent; areolas surrounded by incomplete circlelets of small granules.

Spines referred to this species long, round, slender, and sculptured with delicate longitudinal lines; articulating cavity small, with a smooth rim; head thick, with a thin prominent finely milled ring; body long, much more slender than the head.

Locality.—Kimmeridge clay, Hartwell, Bucks.

Coll. Professor Morris.

Hemipedina Cunninghamii, Wright, nov. sp.

Form unknown, upwards of an inch in diameter; ambulacral areas with two marginal rows of very small tubercles rather irregular in their mode of arrangement; poriferous zones nearly straight; interambulacral areas three times the width of the ambulacral, with two rows of tubercles situated on the zonal half of the tubercular plates, leaving thereby a wide intertubercular space which is filled with 8 to 10 rows of small granules; the bosses large and prominent, and the tubercles of a proportionate size; areolas surrounded by a complete circlelet of small granules the same size as those filling the middle of the areas.

Locality.—Kimmeridge clay near Aylesbury. Collected by Professor Morris.

Coll. British Museum.

Foreign Species from the Kimmeridge Clay.

Hemipedina Bouchardii, Wright, nov. sp.

Test large, depressed; ambulacral areas with two rows of regular marginal tubercles extending without interruption from the peristome to the apical disc, and separated by a median zigzag line of small granules; poriferous zones straight; interambulacral areas three times the width of the ambulacral, with

ten rows of tubercles at the equator, each tubercular plate having five tubercles abreast; areolas surrounded by circlets of small granules; spines slender, sculptured with longitudinal lines.

Dimensions.—Transverse diameter $2\frac{4}{10}$ inches?

Locality.—Kimmeridge clay, Boulogne-sur-Mer. Collected by M. Bouchard Chantereaux.

Coll. M. Bouchard Chantereaux at Boulogne.

In the present state of our knowledge it would be premature to suggest subdivisions, but it is clear that we have two distinct types in the genus *Hemipedina*: 1st, those with two rows of large tubercles, and a wide intertubercular granulated space in the middle of the interambulacral areas; and 2nd, those with four, six, eight or ten rows of nearly equal-sized tubercles in these areas at the equator.

Note on the Subgenus Limea, Bronn.

By JOHN LYCETT, Esq.

READ 28TH AUGUST 1855.

THE present note is intended to direct attention to a peculiarity connected with the external surface of *Limea*, trivial in its zoological importance, but which is calculated from its persistency to be a useful aid to the palæontologist in the absence of hinge characters.

The subgenus *Limea* has hitherto been distinguished from *Lima* solely by the presence of a series of parallel teeth upon each side of the hinge-plate, a feature which cannot be ascertained in the majority of specimens; and the only British species of *Limea* hitherto described has so little in its general aspect to separate it from the young condition of *Lima duplicata* (a shell which is associated with it in the same beds), that any clear external distinction which can be ascertained between them is worthy of notice, more especially when it will also be found to characterize *Limea* as a subgenus.

It is in the auricles that the distinctive feature resides, and it is immediately connected with the hinge-plate beneath: it will be found that the radiating lines which usually ornament the surfaces of the auricles in the *Pectens* and *Limæ* also exist in *Limea*, but that in the latter they abruptly disappear towards the outer angle of each auricle, leaving a small triangular smooth area, which is traversed transversely downwards and inwards by a few elevations; these are placed immediately over and correspond to the grooves which separate the teeth upon the hinge-plate. In all well-preserved specimens this kind of surface is visible upon one or both of the auricles, its distinctness depending upon the condition of the specimen with reference to fossilization and the greater or less prominence of the internal features.

Limea duplicata is abundant in the shelly oolite of Leckhampton Hill; there is also another more ornamented but undescribed species higher in the same formation, and found at many localities in the upper Ragstones of the Cotteswold Inferior Oolite. The peculiarity of the auricles is observable equally in both these species.

Remarks on the Inferior Oolite and Lias in parts of Northamptonshire, compared with the same Formations in Gloucestershire.

By the Rev. P. B. BRODIE, M.A., F.G.S.

HAVING, at a late meeting of the Cotteswold Naturalists' Club, given a *vivâ voce* account of the Inferior Oolite and Lias in a part of Northamptonshire; at the request of the Secretary, I have prepared a more detailed description for our 'Proceedings.' It is well known that certain beds in the Inferior Oolite in the neighbourhood of Northampton have been extensively worked for the ironstone which largely prevails in it thereabouts, though I believe it is not now so generally used for æconomical purposes as it was formerly. This was certainly the case with those quarries which I examined near Blisworth. They are not worked to any great depth, and occupy the higher ground in the district; the strata consist of sandy ferruginous oolitic stone containing a few imperfect casts of shells, though the greater part of the mass is unfossiliferous: the top beds are coarse, and contain impressions of shells; the lower ones are more compact, and are composed chiefly of ironstone. The Inferior Oolite here appears to be of no great thickness, and differs materially from that of the Cotteswolds. The hills which are occupied by it near Blisworth are comparatively low, and form a striking contrast to those in Gloucestershire partly composed of the same formation. The fossils I obtained were a large *Cardium*, a *Trigonia*, a *Pecten*, *Terebratulæ*, and a few Univalves. Fossils are much more abundant at Northampton, though only occurring there in the form of casts.

Upper Lias.—From the position of the Inferior Oolite, the Upper Lias was to be looked for at a low level at the base of these hills, and I accordingly found it in a brick-pit in the valley at Bugbrook between Weedon and Blisworth, below the level of the Railway at no great distance from the Kilsby tunnel. Beds of Lias clay and shale are used for brick-making with the usual Upper Lias fossils, among which *Ammonites serpentinus* and *Belemnites* were very prevalent. The clay is traversed by a thin, continuous layer of limestone, which, as I anticipated, turned out to be the 'fish bed,' identical lithologically with the same band in Gloucestershire, and full of innumerable fragments of fish (though I could discover none entire) and coprolites, with some specimens of *Inoceramus dubius* and traces of *Sepia*.

This 'fish bed' has been noticed by Mr. Morris in parts of Lincolnshire and Northamptonshire on the Great Northern Railway, and it is very probable that it will be detected in other places where the Upper Lias occurs *in situ*, since it is rarely wanting, in its course through Somersetshire and Gloucestershire, at the lower part of this deposit. In fact, this 'fish and insect bed' seems as persistent in the Upper Lias as the 'Insect limestone' is in the lower.

The section at Bugbrook is as follows in descending order:—

	ft.	in.
1. Rubbly white limestone in detached bits, in dark blue shale, with numerous fragments of <i>Ammonites</i>	4	0
2. Thin-bedded limestone ('fish bed'); white externally, inside has a green tinge with white specks; it has a laminated fracture, and splits readily when weathered; it does not occur in nodules, but in a regular thin band in the clay	0	3
3. Thin, coarse, dark-coloured slaty stone, very rough, covered with spines, teeth and plates of Echinoderms, resting on the marlstone.		

The thickness of the Upper Lias visible at this spot did not exceed a few feet; it is succeeded by the Marlstone with the usual fossils. I could not determine the total thickness of the Upper Lias, as there was no section exposed, but there must be a considerable mass of clay between the Inferior Oolite and the small section at Bugbrook, though probably not half so thick as the Upper Lias in Gloucestershire, which, according to Mr. Hull of the Geological Survey, amounts at least to 200 feet in many parts of the Cotteswolds.

These strata, as well as those of the Inferior Oolite, are perfectly horizontal. When the Railway was in progress, the top beds of the Lower Lias just below the Marlstone were exposed at Kilsby, and were as usual very rich in fossils, similar for the most part to those found in the equivalent strata at Campden, and Hewlett's Hill near Cheltenham.

The summit of Edge Hill in Warwickshire is capped by the Marlstone, the Upper Lias having been denuded; but small boulders of the 'fish bed,' containing scales of fish and '*Inoceramus dubius*,' are of frequent occurrence in the vale below, showing that it formerly occupied its normal position above the Marlstone in that district.

At Alderton, in Gloucestershire, the following strata were exposed below the 'fish bed' in April 1856, which seemed to be richer in fossils than usual, and therefore I have noted them here, which will enable the reader to compare them with those at Bugbrook above mentioned.

Brown and dark shales with many *Ammonites*, *Inoceramus*

dubius, *Rostellaria* (abundant), *Cidaris**, *Nucula*, *Avicula*, and *Aptychus*. These are succeeded by two or three blue marly bands divided by shale, which contain a univalve like a *Cerithium*, *Avicula*, *Nucula*, *Pholadomya*, *Pecten*, *Astarte*, and *Ammonites*. A light blue, slightly indurated marl reposes immediately upon the Marlstone. The total thickness of these clays and marls forming the base of the Upper Lias is about 30 feet.

* A similar small species of *Cidaris* (*C. minuta*) occurs abundantly with spines attached in the Upper Lias shale at Gretton near Winchcomb, where a fine specimen of a *Lepidotus* was lately discovered in the 'fish bed,' and is now in the collection of my friend Dr. Wright.

Notes on the Genus Quenstedtia. By JOHN LYCETT, Esq.

READ 16TH SEPTEMBER 1856.

THIS genus of Lamellibranchiate Conchifera, described in the Great Oolite Monograph of the Palæontographical Society, was founded upon two shells figured in Prof. Phillips's 'Geology of Yorkshire,' under the names of *Pullastra oblita* and *Psammobia lævigata*, the former of them being chosen as the type of the genus.

Of *Pullastra oblita*, I have succeeded in clearing and exposing the hinge of each of the valves in many instances, and am perfectly conversant with its characters, which will be found correctly described in the Monograph alluded to. The siphonal, pallial and muscular scars were ascertained in a cast from the Yorkshire Dogger, and upon the characters supplied by these satisfactory materials the genus was founded. Specimens with the test preserved, and which admit of the hinge characters being exposed, are obtained in the upper portion of the Inferior Oolite of the Cotteswolds; a single young example of the species only having been afforded by the Great Oolite of Minchinhampton. In the Great Oolite Monograph it was stated to be allied to *Psammobia*, but distinguished from it by the dental characters of the hinge, and by the absence of an elevated nymphal plate to sustain the ligament. The general resemblance which the aspect of this shell presents to the *Mactromya mactroides* of Agassiz had not been overlooked, but as the figures of *Mactromya mactroides*, in the 'Etudes critiques' of that author, consist for the most part only of casts, which afford no information respecting the hinge, it was considered inadvisable to allude to the probable identity, as it was certain that *Quenstedtia* possessed no affinity either with *Mactra* or with the family of the *Myadæ*, and the shells of Phillips had priority as species. This supposed identity of *Quenstedtia oblita* with the *Mactromya mactroides* of Agassiz, has recently been fully confirmed in the publication by M. Terquem of an elaborate work, with plates, entitled, 'Observations sur les Etudes critiques des Mollusques fossiles, comprenant la Monographie des Myaires de M. Agassiz.' In this work the author has figured and described the *Mactromya mac-*

troides; the figures representing the shell and cast of the interior under different aspects: upon the same plate (No. 5) are placed figures of the recent *Psammobia vespertina* for comparison; the conclusion drawn by the author from this comparison is that *Mactromya mactroides* is a *Psammobia*. It will be observed that in these figures, the author has altogether omitted one of the most essential points of comparison necessary to establish a generic identity, the hinges not being exhibited; he has, however, given casts of the interiors of the valves in both the shells, including the siphonal, pallial and muscular scars, but these afford no information respecting the hinge. The author arranges *Mactromya mactroides* with *M. tenuis*, *M. brevis* and *M. litterata*, all of which group he believes to be *Psammobia*; he also states that the group has a small cardinal tooth in each valve, which he regards as an abnormal variation from the dentition of *Psammobia vespertina*, which has two teeth in each valve. As the author does not state expressly that he has cleared and exposed the hinge in each valve of *Mactromya mactroides*, and as he is careful to record similar facts relating to other genera, I am led to infer that his knowledge of the hinge in the shell in question has been derived either from the partial exposure exhibited by the valves when in contact, or from other imperfect evidence. However this may be, it is certain that the hinge is altogether unlike that of *Psammobia*: to avoid the trouble of reference, I subjoin the hinge characters of the fossil shell:—

QUENSTEDTIA. *Hinge in the left valve consisting of one obtuse, oblong and transverse tooth, slightly compressed from above, situated beneath the umbo and received into a corresponding oblong pit in the hinge-plate of the opposite valve.*

There is therefore no tooth in the right valve and consequently no pit in the left valve. This kind of hinge, which so nearly resembles that of the fossil genus *Myoconcha*, is altogether distinct from that of *Psammobia*, with its two grooved, diverging hinge-teeth in each valve.

The ligament is received into a narrow, lengthened and deep area posterior to the umbones;—the shell is therefore destitute of the elevated nymphal plate of *Psammobia*.

The siphonal flexure, as may be observed in the figure given by M. Terquem, is less considerable than in *Psammobia*, and, unlike that genus, it is united posteriorly to the pallial line *only at its extremity*, so that with the pallial line it forms a narrow tongue, the upper and lower borders of which are limited by the gradual convergence of the two lines: in *Psammobia* the siphonal and pallial lines are united in a position nearly vertical beneath the umbo, and proceed posteriorly united into a single line. The

aggregate of these characters, it must be admitted, fully justifies the separation of *Quenstedtia* from *Psammobia*; and it yet remains to be demonstrated that true *Psammobia* are found in any rocks older than the Tertiary system, none of the so-called Jurassic *Psammobia* having hitherto exhibited the characters of that genus free from ambiguity.

Remarks on the Lias of Barrow in Leicestershire, compared with the lower part of that Formation in Gloucestershire, Worcestershire, and Warwickshire. By the Rev. P. B. BRODIE, M.A., F.G.S., Vice-President of the Warwickshire Naturalists' Field Club.

READ 27TH JANUARY 1857.

DURING a late visit to the well-known Lias quarries at Barrow-on-Soar, I was able to compare the various sections there exposed with those in the equivalent beds in Warwickshire, Worcestershire, and Gloucestershire; and, although I could detect no remains of Insects, nor even a trace of them*, the position of the strata, and their lithological characters, are identical with the true *Insect limestones* in the counties above mentioned.

As Mr. Jukes has already described the lower Lias at Barrow and the neighbourhood in 'Potter's Charnwood Forest,' it will be needless for me to repeat those sections; but it will be necessary to give one not referred to by him, taken from an upper quarry of Mr. Lee's, in order to identify the beds,—where we have, in descending order,

	ft.	in.
1. Alluvial drift, sand and red clay, with rolled boulders of Lias	8	0
2. Blue shale.....	3	0
3. { Hard blue limestone (<i>Rummels</i>), with young <i>Plagiostoma gigantea</i> , <i>Lima rudis</i> , and numerous <i>Ammonites</i> , similar to the <i>Plagiostoma-bed</i> in Gloucestershire.....	0	9
4. Thick blue shale	4	0
5. Blue limestone (representative of <i>Insect-bed</i>)	0	6
6. Black shale	1	2
7. Limestone (representative of <i>Insect-bed</i>)	0	6
8. Black shale	1	0
9. { Blue nodular and crystalline limestone (<i>top hurls</i>)—a very peculiar band, resembling a bed near to the ' <i>firestone</i> ' of Warwickshire, as at Grafton in that county.....	0	6
10. Shale.		
Bottom of quarry.	19	5

As Mr. Jukes truly observes, the strata vary considerably even in adjacent quarries—certain beds thin out and others come

* Although, in the short examination I was able to give the Barrow limestones, I could discover no Insect remains, nor could hear of any ever having been found, it is possible that a closer research would detect them.

in; thus, in Mr. Ellis's large pit on the other side of Barrow, there is at least 30 feet of shale above the '*rummels*,' No. 3 in section, and there are more courses of limestone, especially those which appear to represent the *Insect limestone*. It is worthy of note, that while the *Rummels* No. 3 is evidently the equivalent of the *Plagiostoma-bed* in Gloucestershire and elsewhere, it is succeeded at once by the beds of *Lias*, which in Gloucestershire, Worcestershire, and in some portions of Warwickshire, occur much lower in the series, the intervening strata being entirely wanting in that part of Leicestershire. Most of the quarries do not exceed 30 feet in depth, but some have been opened to a depth of 42 feet, the lowest stratum being a bed of blue marly clay. The limestones are used in Leicestershire for the same economical purposes as the Warwickshire 'paving-stones,' and are equally adapted for this object; but they do not seem to be employed for making hydraulic lime, as they are in the quarries belonging to my friends Messrs. Greaves and Kershaw at Wilmcote, near Stratford-on-Avon.

In places there are several small faults, and in one pit the lower strata were thrown up so as to form a complete saddle, of limited extent, at right angles to Mount Sorrel, not far off,—showing on a small scale what the effect of such a dislocation would be on a large one.

Except in No. 3 of section, shells are scarce; below this, I observed only a few *Ammonites planorbis* and *Aptychus*, and a long shell (*Meleagrina*?) common in the shale at Brockeridge Common, near Tewkesbury in Gloucestershire, and there associated with numerous and beautiful specimens of the same Ammonite.

The fine Saurians and Fish for which this district has been long famous occur more or less in all the shales and limestones, though some courses are richer than others; and for the last two years very few have been met with. In Mr. Lee's extensive collection, the genus *Dapedium* was by far the most abundant, many of which were quite perfect; and among several fine fish, I noticed one nearly 2 feet in length, belonging to a different genus, and in a remarkably fine state of preservation.

The only Crustacean I observed was the *Eryon Barroviensis* (M'Coy), which was small and ill-preserved, and by no means equal to the large and perfect specimens met with occasionally at Bidford in Warwickshire*.

I did not detect any remains of plants.

* This species is not uncommon in the *Insect limestone* at Strensham in Worcestershire (where the finest Insects have been obtained, but the pits are now, unfortunately, closed), and Forthampton, near Tewkesbury, where they are generally well preserved, though invariably of small size.

At Wilmcote in Warwickshire there are indications of numerous faults (which were lately pointed out to me by Mr. Kershaw), in all directions round the district, more than are generally supposed. Thus the 'firestone,' which is the lowest and hardest stratum worked, crops-out at various points and dips at a considerable angle, on the higher ground; and the several bands of 'Insect limestone' and shale lie in a basin formed by the outcrop of this lower bed. The 'Plagiostomabed,' containing *P. gigantea*, *Cardinia ovalis*, and *Astarte lurida*, occurs in places in its normal position; but there appears to be no trace of the underlying Saurian beds, which are of considerable thickness in Gloucestershire, and their absence is to be noted both at Wilmcote and Barrow, which implies a great thinning-out of the lower Lias in that direction. This holds good, at all events, with respect to the lower Lias at the latter place, where there are fewer bands of 'Insect limestone;' but at the former they are more numerous, not less than eight courses divided by thick shale; and as the 'Insect-bed' in Gloucestershire is often confined to one, or at most two layers, only a few inches thick, the increased number of 'Insect-beds' in Warwickshire may represent the 'Saurian beds' in Gloucestershire and other places, with which they were perhaps coeval in point of time.

The 'firestone' above referred to is a hard, crystalline limestone, full of oysters and spines of Echini, from 3 to 7 inches thick. In Warwickshire it always underlies the last bed of 'Insect limestone,' but does not occur in Leicestershire.

I have only seen two specimens of the large *Eryon* from Warwickshire, one of which is in my own collection, and the other in that of my friend Mr. Kershaw. I am indebted to his kindness for another fine but apparently distinct species of this genus.

The largest measures 6 inches in length from the top of the head to the extremity of the tail, and a little more than 2 inches in breadth in the widest portion of the body.

On the Sands intermediate the Inferior Oolite and Lias of the Cotteswold Hills, compared with a similar Deposit upon the Coast of Yorkshire. By JOHN LYCETT, Esq.

READ 28TH JULY 1857.

MY friend Professor Buckman having invited me to throw together some geological conclusions to serve as a foundation for a discussion, I select a subject which has already received some consideration at the hands of the Club, and which, from its local position, and a difference of opinion which has arisen with respect to the zoological affinities of its fauna, seems to claim some further examination. I allude to the series of micaceous sands and marls which are situated intermediate the Inferior Oolite and Lias, and which are known to English geologists generally as the Sands of the Inferior Oolite, and to continental cultivators of the science as the Jurensis marls; the Grès Supraliassique; the Hydroxyde Oolithique; the superior portion of the Upper Lias; the Lias Zeta of Quenstedt, &c. Dr. Wright* and Mr. Hull† have each recently exemplified this deposit in copious and well-known memoirs; but as regards the Cotteswold Naturalists' Club, the present is the first communication which has been presented to it in a written form. The conclusions arrived at by the authors above referred to are based solely upon zoological evidence, and are therefore liable to be affected by subsequent additions, which may tend to alter the relative proportions of Oolitic or of Liassic species found in the deposit; and as some interesting accessions to its fauna have recently been made, more especially in the lower fossiliferous zone, which was but little known until within these few months, I present a notice of them, with the remark, that although as contributions they possess some value, they by no means afford a triumph to any foregone theoretical conclusions;—that they may be compared rather to a portion of the materials forming a part of the structure of a buried edifice whose proportions are not yet fully developed, and of whose full history so much yet remains to be

* "On the so-called Sands of the Inferior Oolite." Journ. Geol. Soc. 1856.

† Mem. of the Geol. Surv. of Gr. Brit. "The country around Cheltenham." 1857.

ascertained, that at present it would be injudicious to indulge in absolute conclusions respecting it. This sandy deposit must be seen to be fully appreciated: presenting much variability in its thickness throughout its long course in the Cotteswolds, it is everywhere readily recognized, and even the approximate position of any small exposures of it may be predicated with tolerable exactness. Unfortunately, nearly the whole of the Cotteswold sections are of a small and imperfect character, consisting chiefly of cuttings of rock upon deep lane-sides, or upon the banks of water-courses; and although these in the aggregate exhibit the entire physical features of the deposit, they do not enable us to ascertain the thickness of the whole, in particular localities, with any near approach to accuracy. We can therefore only estimate the thickness by tracing upwards the beds upon hill-sides, and occasionally by examining the rock brought up during the process of well-sinking. From information obtained in this manner, it would appear that the thickness of the sands varies in the middle Cotteswolds from 35 to 80 feet; and Mr. Hull has shown that over the northern and southern Cotteswolds they present even a greater amount of variability in thickness. My own observations lead to the conclusion, that, like the mass of the Inferior Oolite generally, the thickness is greater upon the outer western escarpment of the Cotteswolds than in the interior valleys, where they are far remote from the outer range. In tracing upwards the beds from the Lias there occurs the following general order of succession:—

- A. Upper Lias clay, grey or blue, soft, and clearly distinguished from
- B. Brown or chocolate-coloured, marly, micaceous sandstone, with frequent red ferruginous stains between the lamination; occasionally the stone is more argillaceous, and buries the hammer when struck; in other instances, from the presence of portions of shells, it is more hard, but is peculiarly irregular and uncertain both in hardness and colour, varying from a blackish-grey to a bright foxy or reddish hue, everywhere glittering with micaceous particles. At about 4 feet from the base are usually one or two thin bands charged with fossils, the greater number of which are very imperfectly preserved: this may be designated as the lower shelly zone, and may be studied in small lane-side sections at Nailsworth and at Brimscombe. In the Yorkshire exposition of the deposit, I shall subsequently show that a shelly zone occurs in a similar position. Passing upwards from 10 to 20 feet, there occurs a general diminution of compactness in the rock, and of its marly structure; there gradually sets in

- C. Micaceous, foxy-coloured or yellowish, incoherent sands, seldom much compacted, but locally becoming soft sandstone, from 20 to 40 feet, abruptly terminated upwards by
- D. Concretionary marly bed, usually darker in colour than the sands, but varying much in structure and aspect within short distances, and everywhere more or less fossiliferous; the tests of Mollusca are less frequently preserved than in the lower zone. A constant mineral feature is the presence of small oval grains of hydrate of iron disseminated through the rock; a structure which, however, is not peculiar, as it is present in the Inferior Oolite at Dundry and in the Lias of France. From 2 to 4 feet is the thickness of this bed in the Cotteswolds.

Immediately overlying this upper Ammonitiferous bed are several others of hard brown or yellowish calcareo-siliceous sandstones, in which fossils are usually very sparingly distributed, and, from the evidence these afford, the beds have by universal consent been assigned to the Inferior Oolite.

In Yorkshire, the lofty iron-bound coast at the Peak and at Blue Wick exhibits the same remarkable deposit in considerable thickness, and slightly modified in its mineral character from the Cotteswold Sands. In a visit which I recently made to this coast, in company with my friend Professor Morris, the identity of the lower portion of the Dogger or Inferior Oolite of Phillips with the Gloucestershire Sands was strongly impressed upon my mind. At Blue Wick the Dogger is altogether about 80 feet in thickness, and rises in successive beds in descending order from the rocky beach into the face of the lofty cliff, the lower 40 feet representing the sands of the Cotteswolds. Beneath these succeed the hard beds of the Upper Lias Shale, 200 feet thick, followed by the Middle Lias, nearly equal in mass; ultimately, at the Peak, facing Robin Hood's Bay, these great deposits are all exposed in one vast unbroken section, forming a lofty mural cliff, nearly 400 feet in height and three miles in length, in the course of which the Dogger attains the summit of the cliff. Words are scarcely adequate to express my admiration of this grand exposition of the lower Jurassic rocks, which for extent and completeness can scarcely be paralleled. Proceeding northwards, the upper 40 feet of the Dogger loses more than half its thickness, and the lower portion, or representative of the Sands, thins out altogether; a great fault then succeeds, by which the Middle Lias is upraised to the summit of the cliff.

The highest bed of the Upper Lias consists of black, finely laminated shale, the transition to the sandstone above being abrupt and very distinctly marked. The sands are here compacted into thick-bedded, dark grey micaceous sandstones in

the lower part, and into brownish or foxy-coloured micaceous sandstones in the upper part, so that the whole nearly resembles the Cotteswold Sands, and differs chiefly in its greater compactness. Fossils are distributed very sparingly throughout the mass of the sandstones, but they are present more abundantly, as in the Cotteswolds, in two calcareo-argillaceous zones, situated in like manner, the one at the top, the other near to the base of the series. The lower fossiliferous zone is a dark grey concretionary band of rock crowded with valves of *Lingula Beanii*; in smaller numbers are *Orbicula reflexa*, *Vermetus concinnus*, *Avicula inæquivalvis*? and another *Avicula*, a small smooth *Pecten*, *Cerithium*, &c. Belemnites are not uncommon, but Ammonites are rare, and are obtained singly and at intervals throughout the sandstones; these are, *A. variabilis*, var. *Beanii*, *A. striatulus*, and *A. Aalensis*; the latter form has not been observed in the Cotteswolds, but occurs in the same stage (Lias Zeta of Quenstedt) in the Jura. *Vermetus concinnus* occurs at intervals throughout the sandstones in small groups, and usually isolated. The dark grey colour of the lower beds of sandstone changes upwards to a foxy hue, and at the summit is the upper fossiliferous zone, from 14 to 18 inches thick, concretionary and dark-coloured; altogether it nearly resembles the Cotteswold bed at Haresfield Hill, with Cephalopoda. In like manner, each abounds with a *Terebratula*, which is its predominating fossil; the Yorkshire shell is the *Terebratula trilineata* of Young and Bird, *T. ovoides*, Sow., a larger form than the *subpunctata* of Haresfield, but which very much resembles the latter shell when collected indiscriminately at each locality, and without preference to presumed typical forms: unfortunately, the Blue Wick specimens are more frequently compressed and distorted. Other fossils recognized are, *Pleurotomaria subdecorata*, D'Orb., which also occurs at Nailsworth; *Belemnites compressus*, *B. irregularis*, and portions of Ammonites. *Rhynchonella cynocephala* has occurred very rarely, and several specimens of *R. bidens* are also recorded. The thick sandstones of the Dogger which overlie this zone abound with small quartzose pebbles, which are never seen beneath the *trilineata* bed.

In Gloucestershire, the lower zone at Brimscombe and Nailsworth has produced the Liassic *Orbicula reflexa*, *Avicula inæquivalvis*?, *Lima Galathea*, *Ammonites Raquinianus*, which is the *crassus* of Phillips, and another tumid form which much resembles it, and may be only a distinct variety. These have not been found to pass into the upper zone; but the oolitic element is fully represented in this lower zone by certain Conchifera, as *Myoconcha crassa*, *Perna rugosa*, *Trigonia striata*, *Pholadomya fidicula*, *Modiola cuneata*, *Goniomya angulifera*, *Mytilus*

humularis, *Modiola unguina*, *Gresslya abducta*, and *Modiola compressa*. The upper zone contains in addition the following Oolitic species:—*Cypricardia cordiformis*, *Hinnites abjectus*, *Astarte excavata*, Sow., var., *A. detrita*, *Macrodon Hirsonensis*, *Modiola Sowerbii*, *Gervillia Hartmanni*, *Gresslya conformis*, *Homomya crassiuscula*. *Pecten textorius* and *Turbo capitaneus* appear to have a considerable stratigraphical range, as they are found from the Upper Lias to the Inferior Oolite inclusive. Of the eighteen Ammonites, which appear to include fifteen distinct species, several are undoubtedly derived from forms which occur in the higher beds of the Upper Lias shale of the counties of York and Somerset; others seem to be proper to the stage, and not one of the Ammonites passes upwards into the Inferior Oolite. The Brachiopoda appear to be entirely Liassic derivatives; and even *Rhynchonella cynocephala*, which, from its abundance and wide diffusion, seems to offer a good designation for the stage (Cynocephala-stage), is perhaps nothing more than a variety of *R. acuta*,—the number of plaits, whether anterior or lateral, affording no constant or reliable distinctive character; in other respects the general figure of both is absolutely the same. The single Nautilus, *N. latidorsatus*, is also Liassic. On the other hand, in the numerous Conchifera the Liassic element nearly disappears altogether, and we find a considerable infusion of the Oolitic, leaving, however, no inconsiderable number of species which appear to be proper to the stage. It is indeed a very striking but undoubted fact, that of the very numerous Liassic Conchifera and Gasteropoda, not more than four or five are continued into the Cynocephala-stage, and even of these two only are found in the upper zone. The more common Upper Lias Ammonites (Lias *Epsilon*) are equally absent in the Cynocephala-stage, as *A. communis*, *A. serpentinus*, *A. bifrons*, *A. annulatus*, *A. exaratus*, *A. elegans*, Y. & B., *A. fimbriatus*. *A. striatulus* is strictly identical with the Liassic form; but the common Cotteswold form of *A. variabilis* var. *dispensus* offers well-marked distinctions from the Liassic variety, which, as it is the *A. Beanii* of Simpson, may be termed the variety *Beanii*. The variety *dispensus* is more compressed, the volutions more enveloped; both the fasciated tubercles and the ribs are smaller, less prominent and more numerous; the ribs being much more curved near to the keel. The Liassic variety, however, occurs very rarely at Frocester Hill. *Ammonites opalinus* I have omitted altogether, as the single specimen found lying upon the ground at Haresfield Hill may have been derived from those superincumbent Inferior Oolite beds to which it has been referred by Quenstedt and Opel. The species alluded to is the *opalinus* of Reinecke, Zieten, and Quenstedt, but not the *primordialis* of

Schlotheim and D'Orbigny, which is sometimes confounded with it. *A. primordialis* is an Upper Lias species. Two forms of these Cotteswold Ammonites appear hitherto to have been undescribed; these will shortly appear, under the names of *A. Moorei* and *A. Leckenbyi**; the former is allied to *Aalensis*, the latter to *hircinus*.

The statement that these Ammonites all cease with the highest bed of the stage, needs some little qualification: a single specimen of *A. striatulus* and *A. variabilis* has occasionally been detected in the lowest of the hard brown beds which overlie the Cephalopod-bed at Frocester Hill; *Belemnites* and *Rhynchonella cynocephala* are more frequent. Whether, however, these Testacea may have been washed into the newer bed, or may for awhile have lingered there as living denizens, is of little moment, as it is certain that the occurrence is of a local nature, and extends only to the lowest bed of the Inferior Oolite.

In assigning to the Sands the provisional rank of a distinct zoological stage, my conclusions are founded upon a review of its fossils compared with those of the Upper Lias "*Epsilon*" on the one hand, and of the Inferior Oolite on the other, to each of which they offer certain approximations, in some instances amounting to absolute identity, in others to the more distant affinities of varieties; after deducting these, a considerable number still remain, which appear to be proper to the stage. This view is to some extent in accordance with that of Quenstedt, who, in his 'Jura,' has separated the Jurensis marls from his Lias "*Epsilon*," or Upper Lias shale, into a distinct subdivision or stage of the Lias, under the name of Lias "*Zeta*." It may be preferable for the present to allow it to remain as an independent stage until more extended observations shall have been made,—more especially until the Testacea of the Lias "*Epsilon*" shall have been more fully figured and described. In this respect it may rank as of the same stratigraphical value as the Cornbrash or the Kelloway Rock, a theoretical arrangement which will leave the problem to be determined by future researches, viz. to which of the two great formations bordering it, its fossils offer as a whole the nearest approximation. Considerable as the list of these has now become, it is evident that much still remains to be done; other localities require to have their fossils better collected and examined. How insufficient is our list from Dorsetshire; how few species have been distinctly assigned to the stage in Yorkshire; how short a time has elapsed since the fossils of the lower zone have been collected in the Cotteswolds; how meagre is the list of M. Eugène Deslongchamps from Cal-

* The Cotteswold Hills: Handbook to their Geology and Palæontology.

vados; and, in the Mozelle, how considerable a number of the species remain undetermined! The recollection of these deficiencies should induce us to discourage for awhile all decisive conclusions, and lead us rather to compare our acquisitions from time to time, carefully and rigidly subjecting them to the necessary comparisons, free from the bias of preconceived opinions.

In the Cotteswolds, 56 Testacea have been obtained in the upper, and 54 in the lower zone; in all, 81 species,—divided into, Cephalopoda, 22; Brachiopoda, 4; Gasteropoda, 9; Conchifera, 46.

The following amended list of fossils from the Cynocephalastage of the Cotteswolds offers some additions and corrections to those previously published, and is divided into two distinct zones.

Upper Zone at Frocester Hill, at Haresfield Hill, and at various other smaller sections.

- | | |
|--|-------------------------------------|
| Ammonites variabilis, D'Orb., var. Beanii. | Opis carinatus, Wright. |
| — variabilis, var. dispansus. | Trigonia Ramsayi, Wright. |
| — striatulus, Sow. | — striata, Sow. |
| — radians Orbignianus, Schlot. | — costata? |
| — radians Dewalqueanus, Rein. | Astarte complanata, Ram. |
| — comensis, De Buch. | — excavata, Sow., var. |
| — insignis, Schub. | — detrita, Goldf. |
| — —, var. with compressed back. | — lurida, Sow., short, gibbose var. |
| — subinsignis?, Op. | Macrodon Hirsonensis, D'Arch. |
| — Jurensis, Ziet. | Gryphæa plicata, Lyc. |
| — discoides, Ziet. | Hinnites abjectus, Phil., sp. |
| — Boulbiensis, Y. & B. | Lima Electra, D'Orb. |
| — Levesquei, D'Orb. | — bellula, Mor. & Lyc., var. |
| — torulosus, Schub. | Modiola Sowerbyi. |
| — Moorei, Lyc. | Pecten textorius, Schlot. |
| — Leckenbyi, Lyc. | Gervillia Hartmanni, Goldf. |
| Belemnites tripartitus, Schlot. | Pinna fissa, Goldf. |
| — irregularis, Schlot. | Goniomya angulifera, Sow., sp. |
| — compressus, Voltz. | Pholadomya fidicula, Sow. |
| Nautilus latidorsatus, D'Orb. | — arenacea, Lyc. |
| Turbo capitaneus, Münster. | Gresslya abducta, Phil., sp. |
| Cerithium papillosum, Desh. | — conformis, Ag. |
| Cypricardia cordiformis, Desh. | Myacites arenacea, Ag., sp. |
| — brevis, Wright. | —, species undet. |
| Cucullæa ferruginea, Lyc. | Homomya crassiuscula, Mor. & Lyc. |
| Tancredia, n. sp. | Terebratula subpunctata, Dav. |
| Cardium Hullii, Wright. | Rhynchonella cynocephala, Rich. |
| Opis lunulatus, Sow., var. | — Jurensis, Quenst., var. |

Lower Zone at Nailsworth and Brimscombe.

- | | |
|--|---|
| Ammonites variabilis, var. dispansus. | Nucula Jurensis, <i>Quenst.</i> |
| — Raquinianus, <i>D'Orb.</i> | Cardium Hullii, <i>Wright.</i> |
| —, species allied to Raquinianus. | Unicardium, sp. indet. |
| — Jurensis, <i>Ziet.</i> | Myoconcha crassa, <i>Sow.</i> |
| — radians Orbignianus, <i>Schlot.</i> | Perna rugosa, <i>Münst.</i> |
| — striatulus, <i>Sow.</i> | Goniomya angulifera, <i>Sow.</i> , sp. |
| — subinsignis?, <i>Op.</i> | Gervillia Hartmanni, <i>Münst.</i> |
| — concavus, <i>Sow.</i> | — fornicata, <i>Lyc.</i> |
| Belemnites compressus, <i>Voltz.</i> | Avicula inæquivalvis?, <i>Sow.</i> |
| — tripartitus, <i>Schlot.</i> | Modiola cuneata, <i>Sow.</i> |
| Nautilus latidorsatus, <i>D'Orb.</i> | — Sowerbii, <i>Sow.</i> , sp. |
| Turbo capitaneus, <i>Münst.</i> | — compressa, <i>Münst.</i> |
| Trochus duplicatus, <i>Sow.</i> | — unguina, <i>Y. & B.</i> |
| Pleurotomaria subdecorata, <i>D'Orb.</i> | Mytilus lunularis, <i>Lyc.</i> |
| Chemnitzia lineata, <i>Sow.</i> , sp. | —, sp. indet. |
| —, species undet. | Lima Electra, <i>D'Orb.</i> |
| Natica adducta, <i>Phil.</i> | — bellula, var., <i>Mor. & Lyc.</i> |
| — Oppelensis, <i>Lyc.</i> | — Galathea, <i>D'Orb.</i> |
| Orbicula reflexa. | — ornata, <i>Lyc.</i> |
| Astarte lurida, <i>Sow.</i> | —, n. sp. |
| — complanata, <i>Ræm.</i> | Pholadomya arenacea, <i>Lyc.</i> |
| — rugulosa, <i>Lyc.</i> | — fidicula, <i>Sow.</i> |
| Trigonia striata, <i>Sow.</i> | —, sp. indet. |
| Cypricardia brevis, <i>Wright.</i> | Myacites arenacea, <i>Lyc.</i> |
| — cordiformis, <i>Desh.</i> | —, sp. indet. |
| Cucullæa ferruginea, <i>Lyc.</i> | Rhynchonella cynocephala, <i>Rich.</i> |
| — olivæformis, <i>Lyc.</i> | — plicatella, var. |

On the Discovery of Cnicus tuberosus at Avebury, Wilts.
By Professor BUCKMAN, F.L.S., F.G.S., F.A.S. &c.

READ 6TH OCTOBER 1857.

IN reporting upon our meeting at Avebury, Wilts, on July 15, 1856, I took occasion to remark upon some interesting plants which I had obtained from the Druidical Circle; and amongst notes upon others, will be found the following:—

“*Cnicus acaulis*, Stemless Thistle, with—anomalous as it appears—stems several inches high. This is one of the forms which has given rise to the many synonyms by which the true species is surrounded*.”

In July of the present year, I found myself at the Avebury Circle, in company with my friend Edwin Lees, Esq., F.L.S., F.G.S., when this Thistle was more minutely examined by us; and, upon carefully getting some specimens up by the roots, we were pleased to find that it agreed in this and other respects with the *Cnicus tuberosus*, Willd., Tuberous Plume Thistle,—a specimen of which appears to have been sent by A. B. Lambert, Esq., to Sir J. E. Smith, and is figured in ‘English Botany,’ t. 2562, to the description of which is appended the following *habitat*:—“A copse-wood, called Great Ridge, on the Wiltshire Downs, between Boyton House and Fonthill, abundantly:” and Smith states that he there gathered it in 1819†.

For many years, however, this form appears to have become extinct in this its original habitat; and it was thought to have been entirely lost to our flora until within the last few months, when my friend Mr. W. Cunningham of Devizes fortunately discovered that a nurseryman in his neighbourhood had propagated the plant from its original stock presented to the nurseryman by Lambert himself. The two or three specimens thus handed down are now in Mr. Cunningham’s possession; and upon paying him a visit at Devizes, on our way from Avebury to Stonehenge, I was gratified to see a specimen in full flower in his garden, as well as two dried examples in his herbarium; from an examination of these, I am enabled to declare their complete identity with those I had so recently gathered at Avebury.

Here, then, we have a curious example of a plant having been

* Address to the Cotteswold Naturalists’ Club, by Prof. Buckman, Jan. 27, 1857, p. viii.

† English Flora, vol. iii. p. 393.

lost for many years in one locality, and subsequently occurring in another; and yet, though the collecting botanist may perhaps felicitate us upon restoring this to the British flora, I have myself great hesitation in receiving it as a true and undoubted species, the grounds for which I would shortly sum up as follows:—

It occurs sparingly at Avebury, surrounded by the true *Cnicus acaulis* and *Cnicus acanthoides* in great abundance.

Its most important distinctive character will be found in the radical tubers, which, in full-grown examples, are somewhat large and fleshy, and unilaterally placed on the rhizome. In smaller specimens the roots are long and flexible, but not expanded into tubers,—which is just the state in which they occur in the *Cnicus acaulis*.

It is true that it cannot be described as *acauline*, as the stem is more than a foot in height; but this is also often the case with the true *acaulis*, as we have now before us examples of this species several inches high.

From these circumstances, in connexion with the rarity of the tuberous form in a plant that seeds so abundantly, each head of flowers being capable of perfecting as many as 150 seeds,—taking also into consideration the well-known sporting propensity of this genus,—I cannot help thinking this to be a *hybrid*; and from the fact of the abundance of the two forms before indicated in its immediate vicinity, we may not unreasonably look upon them as the origin of our tuberous type.

There is perhaps no genus of plants more perplexing to the botanist than that of *Carduus*, which is now made to include *Cnicus*; hence the variation in the number of species in our different floras; and thus Babington heads his descriptions of them with the following significant note—"many hybrids occur in this genus*;" and my friend Lees has kindly furnished me with the following note upon another disputed species, which bears directly upon this question:—

"In August 1856, I found the *Cnicus Forsteri* of Smith, in a field near Crowle, Worcestershire. In the same marshy field was a considerable quantity of *Cnicus pratensis* and a very numerous growth of *C. palustris*. The position of Forster's Thistle was between the *C. pratensis* and *C. palustris*, so as to give rise to an immediate suspicion of its hybridity; and, upon examination, the characters shown by *C. Forsteri* were exactly intermediate also. The leaves were much like those of *C. palustris*, while the stem and flowers were in small clusters, instead of being single as in the latter. Indeed, the result of my examination convinced me that *C. Forsteri* could be only a hybrid; and

* Manual of British Botany, 3rd edition.

this I stated in an account I sent to the 'Phytologist,' and which appeared in the September Number of that Journal for 1856."

For the present, then, I must content myself with having offered presumptive evidence of the non-specific character of what is, after all, a decidedly distinctive form; and as I have brought home some specimens and planted them in my botanical garden, where I shall also introduce the *acaulis* and *acanthoides*, I shall look forward to the results of experiments with these with no little degree of interest, as in all probability, like so many other experiments which I have been enabled to perform in the same direction, these may serve still more to perplex the question "What is a species?"

Cirencester, July 1857.

Note on the Presence of the Fossil genus Isodonta, Buv., in the English Jurassic Rocks. By JOHN LYCETT, Esq.

To James Buckman, Esq., Hon. Sec. to the Cotteswold Naturalists' Club.

DEAR SIR,

Will you have the goodness to communicate to the Club, at their next meeting, that we may claim the genus *Isodonta*, Buv. (*Sowerbya*, D'Orb.), as an addition to the fauna of the English Jura?

The sole species hitherto described is the *Isodonta Deshaysea*, Buv., from the ferruginous Oolite of the Oxfordian beds of the Department of the Meuse. Recently, my good friend Mr. Leckenby presented me with a fine specimen of the so-called *Cucullea triangularis*, Phill., from the Cornbrash of Scarborough. The resemblance in the general aspect of this shell to the *Isodonta* of Buvignier was at once apparent; but it was only upon an inspection of specimens in the British Museum, collected by M. Tesson, that their identity with the Yorkshire shell became a conviction to my mind. Individual specimens vary in their elongation and in the degree of angularity at their infero-posterior extremity: little differences of this kind form the sole distinction between the British fossil and that of the Meuse, and the Normandic specimens in the Museum differ from each other at least to an equal extent. The *Cucullea triangularis*, Phill. Geol. York. i. tab. 8. fig. 31, is from the Coralline Oolite of Malton; it is somewhat less elongated than my Cornbrash specimen, and agrees more nearly with the figures of Buvignier, 'Paléont. de la Meuse,' Atlas, pl. 10. figs. 30-35, except that the figure of Phillips is somewhat more inequilateral from the shortness of the posterior slope: in the Cornbrash specimen, as in those from Normandy and from the Meuse, this feature is less conspicuous; but there can be no doubt that the anterior side is always somewhat more produced than the other; the surface is smooth, but with two distant and strongly-marked folds of growth. The very tumid figure and incurved umbones are the external characters whereby it may be distinguished from *Tancredia*; the test is likewise thicker than in the latter genus. At present it does not seem that the Cornbrash shell can be separated as a species either from that of the Yorkshire Coralline Oolite, from the Normandic specimens, or from those

figured by Buvignier from the Department of the Meuse ; but it is desirable that additional British examples of this rare form should be examined. I need hardly suggest to you the expediency of making a rigorous search in the Cornbrash and the Kelloway rock of the vicinity of Cirencester ; and believe me to remain, dear Sir,

Yours, &c.,

JOHN LYCETT.

Minchinhampton, October 19, 1857.

On some Sections of the Upper Lias recently exposed at Nailsworth, Gloucestershire. By JOHN LYCETT, Esq.

READ 21ST JULY 1858.

So few opportunities are afforded for examining the Upper Lias of the Cotteswolds, so small are the artificial exposures of the stage occasionally made, so limited their extent and depth, that its fossils are almost unknown, and even the thickness of the stage has been very variously estimated. During the author's experience of more than twenty years, the Upper Lias has only been known to him by small sections in clay-beds used for brick-making, and these are usually quite destitute of fossils; some cuttings, therefore, recently made, which exposed the entire thickness of the stage and many of its fossils, have induced him to prepare the present brief notice.

The only authorities for the Upper Lias of the district are—'Outlines of the Geology of England' by Conybeare and Phillips, 1822; 'Outline of the Geology of the Neighbourhood of Cheltenham,' by Sir R. I. Murchison, 1834; the enlarged edition of the latter work by J. Buckman and H. E. Strickland, 1845; 'Memoirs of the Geological Survey of Great Britain;' 'The Geology of the Country around Cheltenham,' by E. Hull, Esq., 1857. In the first of these works the Upper Lias is only distinguished from the other members of the same formation by a useful section given at page 252, exhibiting the succession in the beds upon the western slope of the Cotteswolds at Painswick Hill, by the late Mr. Halifax of Standish; but their thickness is not given.

The following is the section, to which figures are here added, to mark the superior divisions :—

Inferior Oolite	1
Very micaceous sand	2
Sand, with beds of unctuous, slaty, bluish clay	3
Blue clay with septaria.....	4
Thin beds of grey Lias-like marlstone	5
Lenticular balls of indurated marl with Ammonites and parts of Fishes	6
Marly sandstone, a yellowish-brown sandstone, spangled with mica, blue at the heart, abounding with large Belemnites, Pectens, &c.....	7
Marl and clay	8
Clay, with veins of foxy earth containing ferruginous nodules concentrically formed round a nucleus of Lias.....	9
Lias.....	10

1. The lower portion of the Inferior Oolite; thick beds of coarse, calcareous, shelly gritstone, more or less tinged with oxide of iron.

2. The sands of the Cynocephala-stage, with a shelly band at the top, some flaggy argillaceous sandstones in the middle, and a shelly band at the bottom.

3, 4, 5, 6. Upper Lias; no fossils visible in this section.

7. Marlstone or Middle Lias.

8, 9, 10. Lower Lias; but little exposed.

In Sir R. I. Murchison's little sketch of the 'Geology of Cheltenham,' the thickness of the Upper Lias is estimated at 60 or 70 feet; and the following fossils were collected by him from a road-side cutting near Sandywell Park :—*Ammonites bifrons*, *A. undulatus*, *A. annulatus*, *Belemnites acutus*, *B. tubularis*, *B. penicillatus*, *Inoceramus dubius*, *Plicatula spinosa*, *Trochus bisectus*, *Arca*, *Gervillia*, *Lucina*, ?*Modiola*, *Nucula*, *Nautilus*, *Pholadomya*. In the second and enlarged edition of the same work, the authors

estimate the general thickness of the Upper Lias at 100 feet to the fossils given in the former edition are added the following:—*Ammonites falcifer*, *A. Strangwaysii*, *Belemnites Bruguierianus*, *Trochus bisertus*, *Nucula rostralis*, *Æschna Brodiei*, *Astacus*, *Hippolita*, *Cidaris minuta*. In the memoir by Mr. Hull, the Upper Lias is stated to be upwards of 230 feet thick at Leckhampton Hill; it is estimated to be 300 feet at Cleve Cloud; in the hills further northwards, at from 80 to 100 feet; it constantly declines in thickness towards the Oxfordshire boundary of the county, so that at Burford its thickness is only 6 feet. In the southern portion of the Cotswolds it is stated to be only 10 feet thick at Wootton-under-Edge, and about 30 feet at Stroud; but I shall have to show that at Nailsworth, a spot situated between the two latter places, the thickness of the Upper Lias is upwards of 105 feet. The only additional fossils mentioned by Mr. Hull are *Nautilus inornatus* and *Belemnites abbreviatus*.

The sections upon which the present remarks are founded were made in forming several deep drains and a cutting for a carriage-drive upon a steep hill-side preparatory to building a villa and laying out the surrounding ground for ornamental purposes, upon the western side of the valley, and immediately adjoining the village of Nailsworth; it also happened about the same time that a cutting was made along the whole course of the turnpike road in the same valley, towards Stroud, for the purpose of laying down gas-pipes; another small section was also afforded by some alterations made in the mill-stream at Holcomb Mills, about half a mile higher up the valley. The deep-drain sections afforded a view of the higher beds of the stage, even to their junction with the micaceous marly sands of the *Cynocephala*-stage; the other cuttings exposed the lower beds, but less perfectly than the upper ones, and also some portion of the Marlstone series. But although a portion of nearly the whole of the beds was uncovered, the entire area from which fossils could be procured was very inconsiderable. In descending order occurred—

Several feet of blue clay, with intercalated thin layers of dark-coloured shale.

A thin stratum of grey, finely laminated shale, with clusters of valves of *Posidonia Bronnii*.

Brown and blue clays and marly bands containing some irregular layers of hard shale, and of thin bands of blue argillaceous limestone.

Fossils were moderately abundant in the bands of limestone.

Ammonites bifrons was the most conspicuous; *A. communis* was in much smaller numbers; the few other *Ammonites* obtained consisted of *A. falcifer*, *A. heterophyllus*, *A. cornucopiæ*, *A. crassus*, *A. Lythensis*, *A. Jurensis*, and a new species near to *A. Humphriesianus*; a few fragments occurred apparently of *Nautilus sinuatus*, and a single specimen of *N. latidorsatus*. *Belemnites* were comparatively few, as were also *Gasteropoda* and *Conchifera*; the latter included two undescribed species, one of *Tancredia* and one of *Placunopsis*.

In the lower beds bluish-grey clays predominated; but the sections were insufficient to expose an unbroken sequence of the lower beds, although the entire thickness of the stage was ascertained with a near approach to accuracy; the measurement gave a thickness of 105 feet, the beds being free from disturbance. Some few layers of limestone nodules occurred, but their amount was not comparable with those obtained from the Upper Lias of Somersetshire. To the same general deficiency of lime, as exemplified in the paucity and thinness of the limestone bands, may probably be attributed the general scarcity of fossils when compared with the Upper Lias of Somerset; here the chief mass of the deposit consisted of brown and blue clays which were quite destitute of fossils; no remains of Saurians or of Fishes were observed. These conditions present a remarkable contrast to the same stage at Ilminster, with its pale yellow limestone charged with Saurians, Fishes, and a multitude of Mollusca of all classes, numbering probably more than 150 species, notwithstanding that the entire thickness of the stage is only a few feet at that place. To study these, the extensive collection of Mr. Moore, in the Bath Museum, should be visited.

The occurrence at Nailsworth of finely laminated shales with the little *Posidonia Bronnii* in the upper portion is interesting, as identifying the stratum with the continental representative of the same shale: this fragile bivalve appears to be limited to the single stratum indicated.

The large *Tancredia* is the first recorded example in the Lias of England, although upwards of eleven species are distributed throughout our Lower and Upper Oolites; in France and Germany, on the other hand, nearly all the recorded species are Liassic. It is probable, however, that some, or even all of the shells referred to *Tellina* in the "Étage Bathonien" of D'Orbigny belong to the genus *Tancredia*, excluding the two species in his "Étage Bajocien," which belong to the genus *Quenstedtia*.

The following is the limited list of Upper Lias Testacea procured at Nailsworth:—

Cephalopoda.

- Ammonites bifrons*, Brug.
- *falcifer*, Sow.
- *communis*, Sow.
- *heterophyllus*, Sow.
- *cornucopiæ*, Y. & B.
- *Jurensis*, D'Orb.
- *Lythensis*, Y. & B.
- *crassus*, Phil.
- *annulatus*, Sow.
- *Ilminstrensis*, n. sp.
- Belemnites compressus*, Voltz.
- *tripartitus*.
- Nautilus latidorsatus*, D'Orb.
- *sinuatus*, Sow.

Gasteropoda.

- Pleurotomaria*.
- Turbo capitaneus*, Münster.
- Conchifera.
- Astarte lurida*, Sow.
- Lucina*?
- Tancredia læviuscula*, n. sp.
- Posidonia Bronnii*, Münster.
- Placunopsis sparsicostatus*, n. sp.
- Nucula Hausmanni*, Ræm.
- Pecten*.
- Gresslya gregaria*, Ræm. sp. (G. Anglica, Ag.)
- Lima gigantea*, Sow.
- *bellula*, Mor. & Lyc.

Notes on the Testacea.

Ammonites bifrons. A variety with compressed sides, in which the falciform ribs are but little prominent. A few examples occurred of the ultimate condition of growth, in which state it may readily be mistaken for a distinct species, and probably constitutes the *A. Hildensis* of Simpson. The costæ have disappeared upon the whole of the last volution, which presents only densely arranged fine falciform lines which pass over the back and the keel; the lateral sulcation has become indistinct through the flattening of the sides of the volution; the back has lost its rectangular figure and become rounded, sloping obliquely upon each side from the keel, and the two dorsal grooves have disappeared; the keel itself has become more elevated and conspicuous. The inner or smooth portion of each volution overwraps and conceals the costated portion of the preceding volution, so that the entire aspect of the shell is smooth, and it is only by breaking away a portion of the last volution near to the suture that the ribs of the next volution can be exposed and the identity of the species proved. It occurred abundantly.

A. communis. Specimens were indifferently preserved, but exhibited some of those varieties in the arrangement of the dorsal ribs, and in the general figure, which perplex collectors who desire to separate them into the forms named *A. communis*, *A. Hollandrei*, and *A. Braunianus*,—a perplexity which is in no degree lessened by the study of numerous specimens. Further investigations into these forms are desirable.

A. heterophyllus. Badly preserved examples, and few.

A. cornucopiæ (*A. fimbriatus*, Sow.). A single fine example in one of the higher beds. Some casts of young forms, apparently of this species, have been procured in the lower zone of the Cynocephala-stage at Nailsworth.

A. Jurensis. Fragments only in the higher beds.

A. crassus (*A. Raquinianus*, D'Orb.). Evidently the same shell as in the lower zone of the Cynocephala-stage at Nailsworth and in the Upper Lias of Yorkshire.

Ammonites Ilminstrensis, n. sp.

In its general figure it is scarcely to be distinguished from *Ammonites Humphriesianus*; the style of its ornamentation is also very similar to that of the latter species; there are, however, some well-marked differences. In *A. Humphriesianus* the lateral costæ form, with the dorsal, a curvature more or less marked; in the Lias shell, the ribs pass from the suture straight over the sides and back. Usually two, but sometimes three, dorsal ribs unite with one lateral rib. In *A. Humphriesianus* the number of dorsal ribs is somewhat greater; but the most conspicuous distinction consists in the form of the dorsal ribs, which in the Lias shell are much more narrow, elevated, and acute, so that there is a wide space left between each rib. In the young shell the lateral ribs are likewise much elevated and acute, so that they are little larger than the dorsal ribs; there is also some little distinction in the figure of the volutions, and consequently of the aperture, the portion near to the suture overhanging the preceding volution more than in the Inferior Oolite shell.

The septa consist of three large principal lobes, much produced, and of two small accessory lobes. The dorsal lobe is much lengthened, with a single, terminal, very elongated and pointed digitation upon each side of the mesial line; there are two smaller lateral digitations; all the digitations are indented. The superior lateral lobe has its termination trifurcate, the mesial digitation being pointed, and of immense length; but the lobe altogether is less lengthened than the dorsal lobe. The inferior lateral lobe is similar in figure to the superior lobe, but is much smaller and shorter. The two accessory lobes are very small and simple, the second being nearly concealed by the convexity near to the suture. The dorsal saddle is of great width, consisting of two principal divisions, of which the outer is much the larger; each division has two principal branches with numerous indentures. The lateral saddle has two principal portions, of which the outer is the smaller; the indentures are smaller and less conspicuous than in the dorsal saddle. The accessory saddles are small and simple, almost without indentures.

Ill-preserved specimens occurred rather abundantly at Holcomb, associated with *A. bifrons* and *Astarte lurida*. My friend Mr. Moore has favoured me with fine specimens from the pale-yellow bed of the Upper Lias at Ilminster, and smaller

forms of the same species occur in the lower shelly zone of the Cynocephala-stage at Nailsworth. The largest specimen in my possession has a diameter of $2\frac{1}{4}$ inches; the height of the aperture is 6 lines, the opposite diameter 10 lines.

A. falcifer. A few specimens. At Stroud, when the railway was being constructed, a thin band of pale grey limestone was crowded with fine specimens, to the exclusion of all other species.

A. annulatus, Sow. Few, and ill-preserved.

A. Lythensis, Y. & B. Smaller forms than occur at Whitby. It is not the *A. Lythensis* of Quenstedt; the latter is a very different Ammonite.

Belemnites compressus, Voltz. Large specimens in the upper bed, associated with *B. tripartitus*.

B. tripartitus, Schl., agrees with specimens in the Cynocephala-stage at Nailsworth and at Frocester Hill.

Nautilus latidorsatus, D'Orb. (*N. Toarcensis*, D'Orb.; *N. Jurensis*, Quenst.). A single fine specimen.

N. sinuatus, Sow. Fragments only.

Pleurotomaria. Species undetermined, with elevated spire, narrow convex volutions, mesial siphonal rib, and fine, densely arranged, equal encircling lines.

Turbo capitaneus, Münster. Its aspect agrees with specimens from the Cynocephala-stage in the neatness of the ornamentation.

Gresslya gregaria, Rœm. A large tumid species, well separated from congeneric forms. A single specimen.

Tancredia læviuscula, n. sp.

A large elongated species, with an oblique dorsal angle and the posterior border nearly closed. Compared with allied forms, it is more lengthened and less convex than *T. donaciformis*; the anterior extremity is more rounded; the umbo is but little elevated, the posterior side being much extended and its extremity pointed; the height being only equal to $\frac{6}{10}$ ths of the length. It is distinguished by the same features from *T. Deshayesea* and *T. compressa*. A single fine specimen.

Lima gigantea, Sow. This well-known shell occurs both in the Lower and Upper Lias of Gloucestershire. D'Orbigny has separated the older form under the name of *L. edulis*. I do not perceive that the latter possesses any sufficient specific distinction.

Lima bellula, Mor. & Lyc. Delicately preserved, and exhibiting the finely ornamented surface, which is rarely seen in Inferior Oolite specimens. Some of the latter attain larger dimensions and have a somewhat shorter figure, but do not possess any other distinguishing feature.

Placunopsis sparsicostatus, n. sp.

Shell flattened, suborbicular, oblique; umbo raised, submarginal, the surface with numerous irregular, unequal, concentric plications, and a few raised, equal, linear, distant, undulating and radiating ribs, sometimes slightly knotted where they pass over the plications. Diameter 12 lines. A single good specimen.

Nucula Hausmanni, Rœm. Nearly allied to *Nucula Erato*, D'Orbigny, an Inferior Oolite shell both of Yorkshire and Gloucestershire; but the latter species is less angular, less pointed at the extremities, or more ovate and smaller. A single fine specimen.

Posidonia Bronnii, Münt. A delicate papyraceous and somewhat irregular shell, usually indifferently preserved, but occurring throughout a thickness of about two inches in tender, thinly laminated shale. Impressions are abundant, but the test is rarely preserved.

Astarte lurida, Sow. So numerous are the Jurassic species of *Astarte*, and in many instances so nearly allied are they to each other, that the utmost care and precision is necessary, both in descriptions and figures, to convey clear and correct ideas of them in the absence of the fossils; nor under any circumstances can the varieties of aspect which they assume, and the boundaries between species, be in every instance sufficiently defined. The figure of *Astarte lurida* in the 'Min. Conch.' accurately represents a short specimen in the young state, before the arrests of growth had produced irregularity and inequality in the encircling ribs, the verbal description appended being very concise. The following description is the result of an examination of a multitude of specimens in every stage of growth:—

Shell oblique, ovate, moderately convex; umbones anterior, pointed, and incurved; anterior side very short; lunule large, striated, elliptical, excavated, its margin slightly rounded; ligamental margin lengthened, its outline somewhat curved, forming with the other valve a lengthened, smooth, but not deeply excavated area with acute borders; lower margin elliptically curved, internally crenulated. Surface with elliptical costæ, regular in the young shell, subsequently degenerating into irregular and unequal elevations, more especially when the surface exhibits arrests of growth; the costæ are not much raised, rounded, and fully equal in breadth to the interstitial spaces (about thirty-two in a full-grown specimen); the entire surface has fine striations, which follow the direction of the costæ.

Specimens vary much in their length and obliquity; but none are comparable to the Oxford Clay shell figured in the 'Illus-

trations of the Geology of Yorkshire' under the name of *Astarte lurida*: the large anterior side and the small lunule mark the latter as a distinct species.

Several examples of *Astarte lurida* were obtained in the upper portion of the Upper Lias in a mill-stream cutting at Holcomb; it has also occurred very abundantly a little higher in the geological scale, in the lower zone of the Cynocephala-stage at Nailsworth. D'Orbigny ('Prodrome') places it in his "Etage Bajocien," which is probably an error; the English localities cited by him (Fox Hill and Taunton) are not Inferior Oolite; nor does it appear that the latter formation, although so rich in the genus *Astarte*, has ever produced *A. lurida*.

*Annual Address to the Cotteswold Naturalists' Field Club, read by
T. B. LL. BAKER, President, at Gloucester.*

READ FEBRUARY 16, 1859.

AGAIN my friends have we met, and again does it fall to my duty to record, however briefly and imperfectly, the transactions of our Club.

You will forgive me, I am sure, if, on this occasion, I go back somewhat farther than usual, to the time when Sir Thomas Tancred—who, though he never would take any other title than that of Secretary, so long as he staid with us, was the real author and manager of our Club, first called together, in July, 1846, a small party at the "Black Horse" on Birdlip Hill, and in the course of a walk through Witcombe Woods, the Roman Villa, and Cooper's Hill, shewed us how much enjoyment and instruction might be gained by a simple ramble through beautiful scenery, in company with several men who are all more or less skilled; but at least, all interested in that glorious study of nature, in whose honour our meetings are held. On that day, when the sun shone fairly on us, and all went smoothly, we first felt the charm of such meetings in fine weather. But, on our next meeting, when we essayed a Forest ramble, and spite of torrents of rain—such as the skies of the Forest can produce when they please—spent a really enjoyable day, then, indeed, we felt that our love for nature was not a mere fair weather fancy, but one that would stand the test of winter and rough weather.

From that time, for now thirteen years, have we enjoyed our five or six meetings per annum. Our Club has been as full as we thought it prudent to allow; it has been the means of bringing together many men of eminent talents, and uniting them in a common band, and it has, I believe, also been the means of encouraging many

young students of nature, and, by introducing them to those who have been able and willing to assist them, has given a fresh spring and impetus to their zeal. It has given all of us many truly happy, enjoyable, and profitable days; and, which I consider by no means the least of its benefits, it has made us all better acquainted with the objects of most interest, whether of nature or art, in our own county. But much as this is—for a small rural Club to be thankful for—we may say yet more. We do not boast that Sir Thomas Tancred, or any here, originated the idea of such a Club. I believe that, in almost every point, it was a simple imitation of that founded in the North, by Sir William Jardine, Mr. Selby, and Dr. Granville. But, I believe that ours was the first of these field Clubs in the South of England, and that the Woolhope, Worcestershire, Malvern, Warwickshire—aye, and even Sussex and Kentish Clubs—have been encouraged to commence, from seeing how well ours has prospered, and we feel ourselves strengthened and encouraged by a bond of union with similar societies dispersed over all England.

But let us refer to our meetings of last summer, for, imperfect as my notices of our gatherings may be, I believe that even such a slight record of the principal objects of interest to be seen in the different localities, where we have met, is of value, as serving to call the attention of future visitors to the same spot.

On April the 27th, the Club gave both honour and pleasure to its President, by acceding to his request, and holding the winter meeting at Hardwicke. He had urged this experiment because he had long felt that there were, in different parts of the country where the Club might wish to meet, many gentlemen who would gladly exercise hospitality, were it not that the independent feeling (which I trust the Club will always maintain) forbids its being a burden to any one.

Your President was anxious to show that, if others were not too proud to follow his example, this difficulty might be easily overcome. He therefore requested the Club to dine with him, paying the usual 3s. 6d. each for dinner, and he had great satisfaction afterwards, in handing to the Secretary an account of the total cost of meat, bread, vegetables, servants to wait, &c., &c., of the dinner, shewing a balance of nearly a pound due to the Club funds. He would most gladly see this example followed.

The party, before dinner, walked through the grounds, and up Hawklow, Oakleigh or Hockley Hill, on the side of which a Tenant Farmer called their attention to some most hopeless-looking pasture. A slight examination at the time, led to a correspondence and a more careful analysis of the soil, on which a course of treatment was recommended. This is now being carefully carried out on certain marked spots of the field, and the result remains to be seen. If it fails—being only carried out on small portions—the risk is small. If it succeed, not only that Farmer, but many another Farmer and Landlord too, may feel grateful for the visit of the Cotteswold Club.

After dinner some papers were read, which will appear in our annals, and Mr. Jones exhibited a small and evidently simple instrument, which shewed such marvellous effects of the powers of extremely rapid rotation; that, although perhaps it was only an extension of the powers of the humming-top, yet it was so wonderful an extension, that no more business was done that evening, and the fixing of the meetings for that summer were postponed till our next Club day.

On May 18, a considerable party met at Stroud, and walked to the newly-erected Cemetery; where, in addition to a beautiful view of the Valley of Stroud, opening into the great Vale of the Severn, was found a very curious and interesting fault exposed (as all faults must be) by the levelling of the Graveyard. Nor were we less pleased or interested by a collection of curiosities at the house of the Keeper of the Grounds, which shewed that, where taste and ingenuity exist, wealth is not necessary to develope them.

We also visited another fault of about thirty feet in a quarry at Swift's Hill, and then walked to Stroud Glade, where, in a farmyard, we found the yet vigorous remains of a Wytch Elm, hardly to be matched in England. Alas! we were unprovided with measures, and determined to return at a future time better provided—which determination, like many others, has never been carried out. We decided, however, that it was about sixty feet in circumference, and though only a thin shell of wood was attached to the bark, yet the latter was entire, with the exception of a gap some three feet wide, by which we entered, and a hole cut in the opposite side, through which a handle had worked, when the hollow had been used as a convenient shed for a cyder-press. The shell, I think, was from fifteen to twenty feet high, and from thence rose a very vigorous growth of young wood, which is frequently lopped, to prevent its weight from breaking the thin shell of trunk. The manner in which the bark has rounded the edges of some of the small holes in the tree, and formed a complete rose in the hollow, is most curious.

On Wednesday, June 30, a very small party set forth from Tewkesbury to visit the quarries on Brockridge Common, hoping to find there some of our Members who knew the spot, and had promised to attend. After waiting some time, and seeing little, they walked to the neighbouring Church at Ripple, where there was much to please the archæologist, especially when shown by the kind Rector, and returned along the Valley to Tewkesbury. Some little time after they had sat down to dinner the missing and much missed portion of the party came in, having lost much time in hunting for the first detachment. After many regrets had been expressed, and much consultation had taken place as to how such *contre temps* might be avoided for the future, no better means could be suggested than that members should answer the Secretary's letters, and endeavour to reach the place of meeting at the time fixed.

On Wednesday, July 29, a large party of our Club, and a far larger party of Ladies and strangers, met at Gloucester, with the

programme of going by the "Wave" steamer down the Canal to Sharpness, and thence in the "Eagle" steamer to visit the Cliffs of Pennarth (which exhibit at one view the upper beds of the New Red Sandstone, and the entire series of the lower lias beds), and the generally interesting shores of the Severn, including the Bone bed at Aust. Down the Canal we chatted merrily. Boarding the "Eagle" on we steamed, talking of Pennarth, of its interesting Cliffs, and of the friends from Bristol, who had promised to meet us there, and it was only as we neared the Holms, that the truth oozed out, that so deep a bank of mud, impassable to human foot, lay between the water and the Cliff that our landing was impossible, and our scientific examination of the Lias dwindled away to an hour or two strolling about the Holms. However, in misfortune, the only thing to be done is to make the best of it, and so interesting a lecture did we get from the ever-ready Professor Buckman, that many of the less scientific of the party declared that they had gained more instruction and pleasure on the Holms than they could have hoped for at Pennarth.

On September 15 a meeting took place in the Forest of Dean. I myself was engaged with our Regiment of Yeomanry, at Cheltenham, and therefore was not much more than half wet through. But in the Forest I can quite imagine that there was no half-and-half wetting. Mr. Jones, Dr. Watson, and Mr. Ford are recorded to have stood it, and walked it, and, despite of the air and the water, to have taken good note of the earth where the cuttings of the railways and the mines displayed her heretofore hidden treasures. Honour be to the trio who braved the elements. Yet, had not other duties called him, I think that the trio would not have had it all to themselves, but would have been converted to a quartett by the presence of your President. And thus ended the Thirteenth year of our Club.

And now, my kind friends, I am about to resign my office into your hands; but not as usual with the will to resume it, should you, as you have hitherto done, kindly ask me to do so.

I have long felt that, for many reasons, I was unfit any longer to hold such a office. In good truth, I never was fitted for it; but I hoped that my good-will to the Club, my love (notwithstanding my want of knowledge) of the study of nature, and the time and attention I was able to devote to it, atoned in some degree for my deficiency in science.

But, of late years, another study has occupied me. One so engrossing that I have willingly given my heart and my health to the work. It has not, indeed, lessened my love for the glories of nature in any degree. It has not diminished my interest in the prosperity of the Club; but it has so absorbed my time and my strength, that frequently I am incapacitated from attending to any, but the one object of my thoughts. For a time I believed that the difficulty of organizing the system of Reformatories throughout England would soon be done. But as he who climbs a mountain,

when he has surmounted the highest point he could see from the valley, still finds other heights towering far above—so I see less chance than ever of being freed from my labours. Or rather, and more truly, let me say, I see more hope than ever, that so long as it may please God to use my services, there will be palpably more and more to be done.

The work of establishing Reformatories through the length and breadth of the land is indeed finished. Nay, more! Not only is the tree planted, but the fruit is ripening. The numbers of boys convicted throughout England is greatly diminished. But if we take the particular towns where they have been able to send to Reformatories *every* boy on a second conviction, the decrease is large indeed. I have now little doubt that, with our present Reformatories, we can not only keep all England, except London, clear of regular boy-thieves; but that ere next Christmas we can commence taking the worst of those of London, and if so, I have little doubt that we can produce a strong impression, in three years, even on the crime of the Metropolis. But then comes the great and important question of doing the same for adults. Forgive me, my dear friends, that I have been so long talking of my own shop matters. I meant merely to have explained why my time was more than heretofore occupied by other pursuits, and my pen has run away with me.

To return. I have long felt that I was unsuited for the office of your President. I now feel happy to think that you may, if you please, place that office in the hands of one—who both by rank and position, still more by high attainments and knowledge not only of one, but of many branches of that glorious study which we meet to cultivate—will do honour to your choice.

And now, my friends, I bid you not farewell, for I trust that my attendance at your meetings will not be more rare, and certainly my interest in the Club will not be diminished, but I beg you to let me resign the office of your President, only that it may pass into hands which will carry out more worthily and fitly (than I was ever able to do) the true objects of the Cotteswold Club.

Notes on the Inferior Oolite Beds in the neighbourhood of Bath, by
W. V. GUISE, F.L.S., F.G.S.

READ TO COTTESWOLD NATURALISTS' FIELD CLUB, FEB. 15, 1859.

I PROPOSE, in the following observations, to introduce to my associates of the Cotteswold Club a notice respecting the Oolitic deposits in the neighbourhood of Bath, with reference, more particularly, to some peculiarities presented by the Inferior Oolite beds in that district, and to the relations which they offer to those of the Cotteswolds.

In the course of the late autumn I was enabled to devote three weeks to the study of the Geology of the Bath district, in which I had the advantage of the frequent companionship of the well-known and accomplished Palæontologist, Mr. Charles Moore, to whose guidance I owe it that I was enabled to visit many points of interest and importance which would otherwise have escaped my observation.

My remarks having reference more particularly to the beds of the Inferior Oolite, it is not my intention to do more than to glance cursorily at the underlying clays, of the extent and peculiarities of which it is not easy to form a correct estimate; as, in the immediate neighbourhood of Bath, the Lias is rarely exposed to any extent, and, excepting in well-sinking or in digging the foundations of houses, few opportunities offer for its examination.

Lonsdale, in his Memoir on the Oolitic district of Bath, in the 3rd Volume of the Transactions of the Geological Society, estimates the entire thickness of the Lias in that vicinity at somewhat less than 300 feet, and probably this may be viewed as a fair approximate average; but the thickness of the deposit varies considerably in different localities. In the Charlcombe Valley, it certainly exceeds

that measurement considerably; while at the Hamlet of Meadgate or Medycat, seven miles S.E. of Bath, it cannot be estimated at more than from 40 to 70 feet, and may very possibly be less.

The presence of the "Middle Lias," or "Lias Marlstone," is one of the points most difficult of identification in the Bath district, and I must acknowledge, that during the few opportunities I had of studying the question, I was unable to satisfy myself of the presence of that deposit by any recognisable features. I am bound, however, to add that Mr. Moore has satisfied himself of its existence, though in an obscure form, and under altered conditions from those in which it presents itself in the Cotteswold range. At Charlcombe Hill, as well as on the north-western extremity of Dundry Hill, a considerable thickness of very adhesive ferruginous clay appear to occupy the position of the "Middle Lias," and may very possibly be its representative; but if so, its presence is not indicated by any fossils, in so far as I was able to discover, and at Meadgate the Upper and Lower Lias Marls appear to pass insensibly into one another, without any distinct line of demarcation, though the presence of "*Spirifer rostratus*" about the middle of the series would appear to mark the horizon of the "Marlstone." Lonsdale, in his Memoir, speaks of the "Marlstone" near Bath as containing numerous individuals of "a large *Pecten* with obtuse ribs," which might be attributed to *P. aquivalvis*; but, inasmuch as he appropriates the term "Marlstone" to certain sandy beds, interposed between the Lias and the Inferior Oolite, it is plain that he refers to the "Sands" intercalated between these two deposits; in which, however, I was not fortunate enough to observe the *Pecten* in question, nor any other fossil organism whatever. These "Sands" are everywhere present in situ, and exhibit a series of alternating Sands and Sandstones to a thickness of from 60 to 80 feet, to which extent they are exposed at Charlcombe, the only spot at which I was able to trace them throughout their entire thickness, and as this Section presents some features of interest, I will proceed to review it in detail.

SECTION AT CHARLCOMBE.

It will be seen by reference to the map, that the village of Charlcombe lies due north of Bath, niched into the hollow of one of the numerous pretty combs scooped out by the action of the retiring waters, when the coast-line, of which it forms a part, was slowly emerging from the waves of the ancient "tertiary" ocean. The direction of the Valley itself is about N.W. and S.E., and is traversed throughout the greater portion of its length by a small rivulet, which takes its rise in a deep gully, not far from the Church, and it is this gully which affords the Section to which I have adverted.

After passing over the entire thickness of the Lias Clays, which at this point I cannot estimate at less than 600 or 700 feet, the gully intersects the highest beds of the Upper Lias Shales, which are here seen dipping downwards at a considerable angle, the result

apparently of subsidence, and overlaid by Oolitic drift, which covers all the superior deposits. About 25 feet of these Shales are exposed, distinguished by their well-marked character, no less than by the Liassic Cephalopoda, portions of which are abundant. The Shales are overlaid by the "Sands," a series of alternating micaceous Sands and Sandstones, from 60 to 80 feet thick, which appeared to be wholly unfossiliferous. To these "Sands" succeeds the Inferior Oolite rock, about 25 feet in thickness, and exhibiting the following succession of beds, which will be found to be remarkably persistent in character and extent throughout the Bath district:—

1. *Basement bed*.—A hard rock, full of fossils, and especially characterised by the prevalence of *Trigonia costata* and *Rhynchonella spinosa* } 4 to 5 feet.
2. *Coarse Bastard Freestones*.—Rubbly in their upper portions—slightly fossiliferous. } 20 feet.

Now, the point to which I particularly desire to invite attention, is to the fact of the *Trigonia* and *Spinosa Beds*, forming the *base of the series*, and to their being surmounted by 20 feet of freestones; thus apparently inverting the order of sequence exhibited in the Cotteswold sections, and I shall endeavour to show that this relationship holds good throughout the Bath district, extending even to Dundry Hill, where I found similar conditions prevailing.

INFERIOR OOLITE BEDS AT LYMPLEY STOKE.

On the line of railway between Bath and Bradford, and about three miles from the latter town, is the pretty village of Lympley Stoke, looking down upon the Valley of the Avon, whose green expanse is diversified by the frequent windings of the stream, and by the Trowbridge Canal, which traced along the foot of the hills forming the opposite boundary of the valley, is flanked for probably two miles of its course by the beds of the Inferior Oolite, which, emerging from beneath the clays of the Fuller's Earth, present a mural escarpment of extreme regularity until eventually lost beneath the overlying beds, under which they dip at a scarcely appreciable angle within a short distance of the town of Bradford. The extent and regularity of this section render it extremely valuable for the study of the Inferior Oolite series in this district, and it will be found to present characters in all respects similar to those exhibited by the same beds at Charlcombe.

The Canal is at this point hollowed out of the "Sands"—a sub-soil one would imagine, not very well adapted for the retention of water, and about two or three feet of the sands are exposed above the level of the Canal. Resting on these sands is the "basement-bed" of the Inferior Oolite, about three feet in thickness, charged with fossils, amongst which *Trigonia costata* and *Rhynchonella spinosa* are abundant. The texture of the rock is extremely hard and intractable, which renders it difficult to extract fossils in good condition. *Trigonia costata* is most frequently present in the shape of casts;

Rhyn. spinosa is plentiful, and in the crevices of the rock an occasional example may be observed with the spines attached, though not easy of extraction. To these "Trigonia and *Spinosa* grits" succeed about 22 or 24 feet of impure bastard freestones, very much fractured and disjointed, and more or less rubbly and disintegrated in their upper portions—these beds are comparatively devoid of fossils, a small form of *Terebratula perovalis* appearing the most frequent.

The following list of fossils from the "basement-bed" will serve in some degree as a guide to the character of the deposit:—

<i>Lima proboscidea.</i>	<i>Ostrea.</i>
<i>Trigonia costata.</i>	<i>Turbo capitaneus.</i>
<i>Trigonia</i> , 2 species.	<i>Natica.</i>
<i>Pecten.</i>	<i>Rhyn. spinosa.</i>
<i>Gryphæa Buckmanni.</i>	—— <i>obsoleta.</i>
<i>Gresslya adducta.</i>	—— <i>inconstans.</i>
<i>Pholodomya</i> , 2 species.	<i>Terebratula perovalis.</i>
<i>Trichites</i> , abundant.	<i>Serpulæ</i> , abundant.

Nautili and *Ammonites* portions, but not common.

For this list, which does not pretend to give more than a mere outline of the contents of the beds in question, I am mainly indebted to Mr. Moore; but doubtless a careful examination would yield a far larger series to any geologist who could spare time for their investigation.

Besides the sections just described in detail at Charlcombe and Lympsey Stoke, I examined detached portions of the lower beds of the Inferior Oolite at several points around Bath, and at the village of Turley, about seven miles from thence, just above the quarries at Meadgate, and found the "*Trigonia* and *spinosa* grits" forming the *basement-bed*, and resting immediately on the "Sands."

The question that naturally presents itself to the mind of a Cotteswold Geologist, upon a review of the foregoing considerations, is,—what is the position occupied by these Bath Oolites, relatively to the great development of the same beds in the neighbourhood of Cheltenham and Gloucester? Our able colleague, Mr. Lycett, in his clear and intelligent work on the Cotteswold Hills, divides the Inferior Oolites in that district into three stages, distinguished by their characteristic Brachiopods; the *lowest* of which is designated as the *Cynocephala Stage*; the *middle* as the *Fimbria Stage*; and the *highest* as the *Spinosa Stage*. Hence, we should conclude, if this arrangement be generally applicable, that in the neighbourhood of Bath the two lower stages of the Cotteswold Oolites have thinned out, leaving a special development of the *Spinosa Stage*, as the representative of the entire group, and this may possibly prove to be the case; but, in order satisfactorily to ascertain this point, it will be necessary to trace out the beds of the Inferior Oolite, from their area of greatest development in the neighbourhood of Cheltenham, Stroud, and Gloucester, to the position of diminished importance which they occupy in the neighbourhood of Bath.

DUNDRY HILL.

The Oolites of Dundry Hill, near Bristol, have always presented a problem of some difficulty to Cotteswold Geologists, who have found it no easy matter to apply their own local subdivisions to the 30 or 40 feet of rags and freestones there developed, so as to bring the two sets of deposits into harmonious relations with one another.

Mr. Lycett, though evidently entertaining some doubts respecting the true correlation of these beds, offers a solution of the question as follows:—He says, “at Dundry the quarries are capped with rag-stones, which seem to belong to the *Spinosa Stage*; this is underlaid by useful building freestones, and by sandy Oolite, in all nearly 50 feet thick, which, probably, represent the *Fimbria Stage*. The *Cynoccephala Stage* is here represented by only half-a-yard of ‘*Sands*’ overlying the Upper Lias Clay.” We have here the Cotteswold series apparently identified at Dundry, and I visited the quarries with the expectation of being able to recognise the equivalents of the three stages as laid down by Mr. Lycett; but I am bound to record as the result of my observations, my persuasion that the Dundry beds are a repetition and extension of those at Lympsey Stoke and Charlocombe, having the *Trigonia* and *Spinosa* beds at the base, and resting on the “*Sands*” as in the last-named localities, but with a greater extension upwards of the freestones, which likewise assume at Dundry a purer grain, and more even and regular characters.

The Freestones at Dundry occupy the eastern extremity of the hill, from which point, followed along their line of strike, they rapidly attenuate, so that within an area of less than a mile from their point of greatest extension, they cease to be any longer traceable. The principal quarries are near the Church, and in what is known as the “Upper Quarry” the following beds are exposed:—

1. Rubbly beds..... 4 feet.
2. Hard gritty rock 9 ”
3. Freestone beds..... 6 ”

In these beds fossils are by no means abundant, or of good differential type; but lying amongst the débris which surround the margin of the quarry, I found a block of stone precisely identical in characters with the “basement-bed” at Lympsey Stoke, and like that charged with *Trigonia Costata* and *Rhynchonella Spinosa*. Whence derived was the question, and an inspection of that and the adjoining excavations affording no satisfactory explanation, I awaited the return of the quarrymen from their dinner to obtain information on the subject; and learnt, in reply to my enquiries, that the rock in question lies *at the bottom of all*, and reposes upon a stratum of clay, which in its turn rests upon *Sand*. The clay was described as a water-bearing stratum, and in sinking a well for water in the quarry, the workmen had brought up the blocks of “*Trigonia* and *Spinosa* grit” from the position indicated. The clay band would appear to be a merely local and accidental deposit; and I heard a

story of a man whose well was supplied from this stratum, who not being satisfied with the quantity of water yielded, and desiring to increase the supply, penetrated to the underlying sands, and lost the pure element altogether. The following is the succession of beds as furnished by the quarryman:—

Rubbly beds	4 feet.
Hard gritty rock	9 „
Freestone beds	6 „
Hard coarse freestone	3 „
Rubbly stone	8 or 9 „
<i>Shelly-bed</i> , containing <i>Trigonia</i> and <i>Spinosa</i> ..	3 „
Blue Clay	4 or 5 „
Sand	

in all about 33 or 34 feet, exclusive of the clay band. I could find no example of *Trigonia*, or *R. spinosa*, in the overlying beds; though Mr. Moore informed me that he had taken *R. spinosa* in a young form in the Upper Rags, and had even met with it as high up as the Bradford Clay.

The considerations which present themselves on a review of the foregoing facts, are of a nature to prevent hasty conclusions; but I think I have shown sufficient reason to justify and call for a more complete and methodical investigation of the intermediate circumstances which mark the passage of the Bath and Dundry beds into those of the Cotteswold series, so as to ascertain how far, and to what extent the division of the latter series into different stages, characterised by special Brachiopods, can be maintained over a more extended area; or whether such subdivisions are not of merely *local value*, and, in that respect, rather an hindrance than an aid when applied to the definition of beds, in the deposition of which different circumstances have in all probability prevailed.

*Annual Address to the Cotteswold Naturalists' Field Club, read by
W. V. GUISE, F.L.S., F.G.S., President.*

READ FEBRUARY 23, 1860.

GENTLEMEN,—In compliance with the custom of the Club it becomes my duty to lay before you an outline of the general working of our Society, and of the progress of Science in connexion with it, during the past season. In doing so, I am happy to have it in my power to congratulate you upon the results. It is true that I cannot point to many written papers as evidence of our activity; yet, in proof that we have not been idle, the records of our meetings will shew a goodly array of facts established, and of doubts resolved, which are after all amongst the most valuable results within the reach of local contributors to Science.

In estimating the advantages of such an association as ours, it must be borne in mind that the good which we effect is not limited to the registration of facts in connexion with local phenomena, essential and important, though such functions undoubtedly are. Our gatherings in out-of-the-way nooks and corners; our rambles over hill and dale, by pool and stream, in leafy woodland, or on breezy down; the free interchange of thought and feeling between congenial minds; all these conditions and circumstances tend to promote that love of Nature and of Natural Science, which the Field Clubs in especial have done so much to foster and develope.

The chief danger to be apprehended, perhaps, from the social character of our meetings is lest we should degenerate too much into the habits of mere "pic-nickers." From this risk, however,

our Society has been hitherto redeemed, by the valuable and important work done by the able observers and skilful Naturalists it is our good fortune to rank amongst our members. It will suffice to mention the names of Wright, Buckmann, Jones, Lycett, Brodie, and Symonds, to recall at once names of writers well known in the scientific annals of the country, and of whom some have by their works obtained a more than European reputation.

To preserve such a Society in its full vigour and activity, is no light responsibility for any individual, let his accomplishments or fitness for the task be what they may; and it was with the utmost diffidence, and with a heavy sense of the importance of the charge, that I permitted myself to be nominated for the office of President at the commencement of our last season; and this sense of responsibility was in no degree lessened by the fact, that I was called upon to succeed in office, one of the most justly popular Presidents that ever conducted the affairs of any similar association. My predecessor, Mr. Barwick Baker, was at the birth and founding of this Society; indeed, I may say, that in conjunction with our amiable friend, Sir Thomas Tancred, he was our parent and founder—"fons et origo"—and during thirteen years, in the course of which, his supervision never relaxed, nor was his tact found wanting; he saw it grow and gather strength, until our reputation stood amongst the highest of similar societies, and our example becoming contagious, gave rise to vigorous off-shoots in the neighbouring Counties, of which the Field Clubs of Woolhope, Malvern, Worcester, and Warwick are living and flourishing evidences.

With the strong sense then that I entertained of the disadvantage of following such a predecessor, I may well be believed, when I assert that it was with hesitation and reluctance that I consented to accept the office of President of the Cotteswold Club. Relying, however, upon the kind support of the members, and on the invaluable assistance of our able and indefatigable Secretary, Mr. Jones, I undertook the duties of the office, and I am thankful to say, that thus sustained, I have found my task comparatively easy; and at this, the termination of my year of office, although, as I have said, our proceedings have not been illustrated to any extent by written contributions, yet I can point with satisfaction to the work accomplished, to the healthy and vigorous condition of the Club, to our increased numbers, and to the undiminished interest in our proceedings, as testified by the usually full attendance at the different places of meeting.

The annual Meeting of the Club was held at the "Ram Inn," Gloucester, on the 15th of February, 1859, when T. B. Ll. Baker, Esq., after reading an address reviewing the proceedings of the past year, to the regret of the Club, vacated the Presidential chair, Professor Buckman at the same time retiring from the post of Secretary.

W. V. Guise, of Elmore Court, was then elected President, and John Jones, of Gloucester, Secretary, for the ensuing year.

A discussion then ensued upon a proposition of the President, "that the Club should no longer be limited to 50 members," which proposed alteration was finally determined upon.

A party was afterwards organised to visit the "Marlstone" quarries at Churchdown, in which several members joined; whilst others visited Highnam and Lassington, or inspected the Secretary's interesting Cabinets of fossils.

About 80 gentlemen sat down to dinner, which was served by "mine host" of the "Ram" in a style which drew forth well-merited encomiums.

After dinner the following new members were elected:—

J. J. Watson, Ph. D., F.G.S., &c.,
 Rev. F. Smithe, M.A., F.G.S., Churchdown.
 Charles Prentice, Esq., Cheltenham.
 Dr. Buchanan Washbourne, Gloucester.
 W. C. Lucy, Esq., Gloucester.

The President read a paper upon the "Oolites in the neighbourhood of Bath;" the purport of which was to shew, that throughout the Bath district, and extending even to the quarries at Dundry, the *Trigonia* and *Spinosa* beds, which occupy the upper zone of the "Inferior Oolite" in the neighbourhood of Gloucester and Cheltenham, and overlie the well-known freestone-beds in that district, are there found resting immediately upon the so-called "Lias Sands," and having above them beds of bastard freestone, which at Dundry, in particular, assume the form of a true freestone, and are worked as such.

The reading of this paper gave rise to an animated discussion, which assumed at length, to the regret of all listeners, the form of a personal altercation. Surely, it is not out of place here, to express the hope that, that most useful feature of our meetings, the discussion of points of scientific interest and importance may be conducted without serimony and without "o'erstepping the modesty of nature." Let us remember that there can be *no dogmas in science*. The experience of every day is teaching us how dangerous it is to lay down laws, and to insist upon the adoption of theories as though they were incontrovertible truths, more especially in Geology. The vast book of Nature is open to all; but he only is a true philosopher and a worthy interpreter of her pages, who reads in a humble and teachable spirit, feeling after all, how small a portion the wisest among us can hope to have the privilege of contributing to the great ocean of Truth, the depths and boundaries of which lie all undiscovered beyond. "In Geology," says General Portlock, in his Address to the Geological Society, "there can be no partizanship, as the object is not to support the territorial rights of formations, but to arrive at truth."

With these observations, which I hope will not be deemed intrusive, I will proceed to give the substance of the remarks which fell from our able colleague, Dr. Wright, with reference to the beds referred to in the President's paper before-mentioned. He divides

the Inferior Oolite into three zones, whereof he styles the *lower* the zone of *Ammonites Murchisonæ*; the *middle* the zone of *Ammonites Humphresianus*; and the *upper* the zone of *Ammonites Parkinsoni*; these subdivisions having different degrees of development in different parts of the counties of Gloucester, Somerset, and Dorset, being thick, thin, or absent, as the case may be. The upper zone is, he states, the most persistent throughout England, France, and Germany. The middle zone is only feebly represented in the northern Cotswolds, but fairly developed at Dundry; the lower zone having its best development near Cheltenham.

The Charlcombe and Limpley Stoke beds near Bath, are referred by the Doctor to the upper zone, the middle and lower zones being absent.

For a more ample and complete exposition of Dr. Wright's views upon this subject, I would refer enquirers to the very learned paper upon "The Subdivisions of the Inferior Oolite in the South of England," read before the Geological Society, in April, 1859, and now published in the February number for the present year of the *Quarterly Journal* of the same Society. It is a masterly resumé of the entire subject, conducted with admirable patience and research, and illustrated by an amount of learning both literary and palæontological, which must ever render the paper indispensable as a work of reference to all students of the Oolitic Series, whether they accept the Doctor's limitations and subdivisions or not.

May 11.—The Club met at the "Lamb Inn," Cheltenham, and mustered in considerable force. After breakfast, an omnibus conveyed the party to the foot of Cleeve Hill, where the Geological Section, under the direction of the late President, and Messrs. Brodie, Norwood, and Jones, proceeded by the lane which passes between the "Rising Sun" and Mr. Dobell's residence at "Cleeve Clouds," to investigate the stratigraphical position of the so-called "Roadstone" of the district, the characteristic fossil of which is *Terebratulina Phillipsii*. While the Entomological Section, represented by the President, and the Rev. T. A. Marshall, took the lower ground through the village of Bishop's Cleeve.

To the Secretary, I am indebted for the following account of the proceedings of the Geologists, and for the very valuable list of fossils annexed, of which few could have furnished so ample and reliable a catalogue:—

These beds—those containing the "Roadstones"—are clearly much out of place, and must, when "in situ," have been superior to those of the *Fimbria Stage*, which now cap the hill immediately above them. Previously to having seen them, the Secretary, from the account given of their fossil contents by Messrs. Norwood and Bromby, ventured to assign to them a stratigraphical position, and the subsequent examination of their organic contents, as well as of their lithological characters, confirmed him in the opinion he had expressed; namely, that these beds are the equivalents of those, which at Ravensgate, Cooper's Hill, and Haresfield, immediately

underlie the well-developed "Gryphite grits," and contain the greater numbers of the fossils in the following list :—

Brachiopoda.

- Terebratula Phillipsii*.
 ————— *Buckmanni*.
 ————— *perovalis*.
Rhynchonella pinosa.
 ————— *quadriplicata*.

Monomyaria.

- Avicula costata*.
Gervillia tortuosa.
Gryphæa Buckmanni—in the more rubbly portions.
Hinnites tuberculosus—Goldf.
Lima proboscidea.
 ——— *bellula*.
Ostrea (Marshii) ?
Pecten—Scarcely distinguishable from the *P. pleuro-*
nectes, and from the large smooth *Pecten* of
 the Lias Marlstone.
Trichites—Large fragments.

Dimyaria.

- Astarte rhomboidalis*.
Cardium ————— ?—Large casts.
Gresslya abducta—Very large.
Cucullæa ——— ?—Casts.
 ——— *oblonga*.
Lithodomus ? fabella—Abundant.
Macrodon hirsonensis.
Modiola ————— ?—Hull.
Pholodomya fidicula.
Pholodomya ——— ?—A large species, apparently
 unnamed.

- Trigonia costata*.
 ——— *decorata*—Lycett.

Gasteropoda.

- Melania striata*.
 ——— *leckhamptonensis*.
Pleurotomaria—(Casts).

Cephalopoda.

- Nautilus*—Large species, broken and in casts.
Ammonites Humphresianus.

It may be observed that, at Cooper's Hill, good and typical specimens of *Terebratula Phillipsii* not unfrequently occur, as well as of *T. Buckmanni*, the latter most frequently, in a sandy-bed at the base of the "roadstone;" whereas at Cleeve, from one block of stone, may be obtained numerous specimens, which present every conceivable shape of character between *T. Buckmanni*, and what

would generally be considered immature forms of *T. Phillipsii*, the aged and typical form of the latter occurring most frequently in the upper and more rubbly portion of the quarry. These observations lead naturally to the inference that *T. Buckmanni* will eventually be pronounced to be merely a young form of *T. Phillipsii*, as we have only to produce—using the term in its technical sense—the outline of typical *T. Buckmanni*, to obtain the perfect form of the other species.

It is also worthy of remark, that in the *Trigonia beds* at Haresfield, which are no longer gritty, but flaggy in structure, and from which the contained fossils may be disembedded without much difficulty, a form of *Terebratula* abounds, which is generally called *globata*; but upon comparing it with its predecessors, to which the foregoing remarks apply, it will be seen at a glance that it quite as nearly resembles them, as the species to which it is generally assigned.

The entomological event of the day was the capture, by the President and Mr. Marshall, of six individuals of the rare rhynchophorous beetle *Platyrhinus latirostis*, taken upon decayed ash-pollards, feeding on *Sphæria concentrica*—(Berkeley), *Sph. fraxinea*—Sow., with which their trunks were embossed.

On Thursday, 19th of May, the Club assembled at Apperley Court, by invitation from H. Strickland, Esq., to meet the gentlemen of the Malvern, Woolhope, and Worcester Nat.: Hist.: Field Clubs; and were entertained in a style of genuine old English hospitality, which well illustrated the high esteem and regard in which the kind-hearted host holds the cultivators of those delightful sciences, from which he has himself, during a long life, derived so much pleasure, and with which the name of his family will ever be honourably associated.

After dinner, by permission of our host, scientific discussion was invited, and the

Rev. W. S. Symonds, of Pendock, President of the Malvern Field Club, proceeded to announce the discovery of a *Pteraspis*, an "Old Red Ganoid" in the Lower Ludlow Rocks of Leintwardine, by Mr. Lightbody. This is a most important discovery, as fish-existence is thereby carried two steps lower in the geological scale than it had been previously supposed to range. In the words of Mr. Symonds, at a recent meeting of the Malvern Field Club, "this discovery greatly antedates the period during which fish have been proved to have existed; for the whole thickness of the 'Upper Ludlow Shales,' and the 'Aymestry Limestone' intervenes between the grave of the *Pteraspis* of the 'Upper Ludlow Shales,' and that of the *Pteraspis ludensis* (Salter) of the Lower Ludlow Rock of Leintwardine."

Mr. Jones then introduced to the notice of the meeting, the remarkable discovery made by Dr. Falconer, in the Cave of Maccagnone, near Palermo, of human implements in flint, together with

the fæces of a Hyæna, and the teeth and bones of extinct Mammals, cemented underneath a stalagmitic deposit to the roof of the cave; from which Dr. Falconer drew the inference, that the cave had been filled to the roof during the human period, so that a thick layer of bone-splinters, teeth, land-shells, and human implements, had been agglutinated together, and that, subsequently, and within the human period, such a change had taken place in the physical configuration of the district, as to cause the cave to be emptied of its contents, excepting the patches cemented to the roof.

This is only one of the many startling facts which have been of late brought to light; which, with accumulating force and volume, seem to constrain the admission that man was at one time contemporaneous, not only with animals now extinct, but with a conformation of surface, and a distribution of land and water, very different from that which now exists on the surface of the globe.

The occurrence of human implements associated with the teeth and bones of extinct species of Elephant, Rhinoceros, Bear, Hyæna, Tiger, Stag, and Ox, in stratified gravel on the Chalk-hills of the Valley of the Somme, near Abbeville, and at St. Acheul, near Amiens, together with the late discovery in Brixham Cave, in Devonshire, of flint weapons in company with the bones of extinct animals, have brought the co-existence of them with man prominently forward amongst Geologists, who seem to be arriving at the conviction, that man and the extinct mammals referred to, were at one time contemporaneous, and if so, and the physical facts in connexion be correctly interpreted, then it would appear to follow, that the existence of man upon the earth must be ante-dated to a period immeasurably far beyond the 6,000 years to which the human epoch has been usually limited.

These are indeed startling facts, and the wonderful conclusions to which they seem to lead, may well make us hesitate before we adopt them in their full extent. Nevertheless, howsoever our interpretation may be at fault, the facts of Nature are incontrovertible. They are the acts of *the Almighty Creator Himself*, and have been written by Him "for man's understanding," in characters as imperishable as the rocks on which they are inscribed; and we may feel perfectly satisfied that *if the facts be true, and they be truly interpreted, we must accept the conclusions*, no matter how much they may appear to militate against preconceived opinions, or against the apparent meaning of written records.

On Wednesday, the 15th of June, the Club met at Dursley. The President, Secretary, and the Rev. J. H. Deane, proceeded from the Berkeley-road Station through the Stinchcombe Marlstone quarries, where nothing worthy of record was found, to a quarry, on the top of the hill above Dursley, where the stratigraphical relations of the beds are well shown. In descending

order the *Trigonia* grit comes first into view, then a bed about eight feet in thickness, without any distinctive fossil, so far as we could discover, and then the "freestone," which is at that point about 60 or 70 feet thick. The *Fimbria* bed appears to be totally unrepresented. Below the "freestone," the *Cephalopoda* bed, and the upper portion of the subordinate "Sands," come into sight; but the beds, intervening between these and the base of "the freestone," are obscured by rubble.

The "Sands" were here tenanted by a colony of Mason-wasps, *Odynerus spinipes*, accompanied by their parasite *Chrysis bidentata*.

After breakfast the party, with a considerable addition to its strength, proceeded to Peakdown, in a road-cutting on which is displayed the best section of the Supra-liassic Sands yet visited by the Club, as they here attain to an estimated thickness of at least 200 feet. Upon these repose, well-exposed, the "*Cephalopoda* bed" with all its characteristic Ammonites, with the addition of many other interesting fossils, of which the following list was made:—

Ammonites jurensis.

———— *variabilis*.

———— *radians* and var. *Thouarsensis*.

———— *opalinus* and var: *Moorei*.

Belemnites irregularis.

———— *abbreviatus*.

Nautilus inornatus.

Trigonia Ramsayi—(Casts).

Opis.

Astarte.

Turbo capitaneus.

Pholodomya Zitheni.

Pecten demissus.

Cucullæa.

Gresslya abducta.

Modiola plicata.

Lucina.

Serpula.

A large *Pinna* and *Ceromya bajociana*, with other fossils, were found in the upper portion of this bed; but, as at Haresfield and Frocester, these have all been found only in the upper zone, and as it was exceedingly doubtful whether they were here *in situ*, to say nothing of the very doubtful character of the matrix in which they were embedded, the Secretary decided upon rejecting them.

While the majority of the party remained here, the President, Secretary, and others crossed the intervening valley, and made for Uley-Bury. About half-way up the hill, and at about the middle of "the Sands" before referred to, the Secretary discovered an intermittent nodular band of brown stone, similar to that

described by Mr. Lycett, as occurring at the base of the same beds at Nailsworth, and containing a great number of the same fossils.

This most interesting discovery again raised the moot point respecting the relationship of these "Sands" to the beds immediately above and below them. The Secretary, in common with others of our most observant and skilful Palæontologists, deeming that the passage thus traced throughout these "Sands" of Oolitic forms of lamellibranchiate Molluscs in greatly preponderating proportions, intermingled, however, with true liassic forms, determines the transitional characters of the beds in question, and entitles them to have assigned to them a distinct position as an intermediate zone between the Lias and the Inferior Oolite. On the other hand, our learned colleague, Dr. Wright, arguing from the liassic type of the Cephalopods in the bed above, allocates the "Sands" with the liassic series below; this too being the position now generally assigned to them by the leading Continental Geologists. It is, however, but just to add, that English Geologists seem by no means as yet to have made up their minds upon the subject. It appears to me to be quite one of those points which a local society like ours may well set itself to clear up; though, in doing so, it must be borne in mind that the facts which we furnish, though most valuable, are strictly local, and must be considered, not merely with reference to the phenomena which they more immediately illustrate, but that they must be compared with facts, from other and more distant localities, carefully collected by competent observers, and all bearing upon the same point. Thus, and thus only, can we hope to arrive at truth, and by degrees to unravel the great mystery of the succession of life during the countless ages of geological development.

At this Meeting the question of the Cleeve Hill *roadstones* was again brought under discussion, when Dr. Wright fully assented to the position assigned to them by the Secretary, and proceeded to explain his views upon the subject by a lecture, which he illustrated by diagrams with chalk upon a black board.

Dr. Wright has favoured me with the substance of his remarks in writing, which I deem of sufficient value and importance to embody in this address. They are as follows:—

Remarks, by Dr. WRIGHT, on the "Roadstones" of Cleeve Hill

On leaving the Winchcombe road, about a quarter of a mile beyond the "Rising Sun," by the new stables, and ascending the escarpment at this point, the "Pea-grit" is seen in situ near the wall, containing *Terebratula simplex*, *Pygaster semisulcatus*, numerous fragments of Pentacrinites and other fossils of this rock. A few yards above, the Freestone, much displaced, crops

out. Southwards, and still higher up the hill, we enter the quarry called by the workmen the "Rolling-bank." In Sheet 44 of the Geological Survey this escarpment is marked "tumbled Oolite and undercliff," names which alike indicate the disturbed condition of the beds, produced probably by a slip of the Oolitic strata over the unctuous clays of the Upper Lias.

The *Lower Trigonía Grit*, which is seen in situ on the plateau above, has here rolled over and formed the glacis of the hill, it has thereby covered the beds of the "Humphresianus Zone" which immediately underlie it. Recent workings having more fully exposed these "Humphresianus" beds than formerly, I have collected therefrom, a series of fossils characteristic of the "Fauna" of this zone—and have lately ascertained the stratigraphical sequence of the beds composing this middle division of the Inferior Oolite in the northern Cotteswolds.

The "Rolling Bank Quarry" is capped by about 18 inches of the "*Lower Trigonía Grit*," composed of loose incoherent fragments of a light coloured Oolitic limestone, beneath which are exposed the uppermost beds of the "Humphresianus" zone, consisting of

No. 1.—The *Phillipsii-bed*—is a light buff coloured, compact earthy limestone. Many of the blocks are composed of the shells of *Brachiopoda*, of which that of *Terebratula Phillipsii* greatly predominates. The bed measures from two to four feet in thickness, and contains,

Lima proboscidea—Sow.

Pecten ———— ?

Terebratula Phillipsii.

———— *perovalis*,

———— *carinata*.

———— *Buckmanni*.

Rhynchonella spinosa.

———— *tetrahedra*.

No. 2.—The *Roadstone-bed*—consists of a coarse brown ferruginous oolitic limestone, extremely hard and crystalline, in some parts traversed by sandy layers, in others, containing calcareo-siliceous concretions, which have a crystalline structure and uneven fracture; it forms a durable road-material, and is raised for that purpose. The bed varies from 10 to 15 feet in thickness, and contains a small assemblage of *Mollusca*, which are nearly all in a state of moulds; a few species have their tests preserved. The *Trichites* are very large, and sometimes well preserved in the rock, but cannot be extracted entire. *Pholodomya Heraultii*—Ag., attains likewise a gigantic size. The following species occur in the bed :—

Cephalopoda.

Ammonites d'Orbignana—Wr. *Brogniarti* d'Orb. non. Sow.

Ammonites Humphresianus—Sow.

———— *Brocchii*—Sow.

———— *Braikenridgii*—Sow.

Gasteropoda.

Chemnitzia Samanni—Oppel.

Pleurotomaria fasciata—Sow.

———— *elongata*—Sow.

Turbo laevigata.

Conchifera.

Ostrea flabelloides—Lamk.

Hinnites tuberculosus—Goldf.

Lima proboscidea—Sow.

———— *Etheridgii*—Wr.

———— *nov. spec.*?

Trichites undulatus—Lyc.

Astarte excavata—Sow.

Mytilus explanatus—Mor.

Pholodomya Heraultii—Ag.

Homomya crassiuscula—Lyc.

Myoconcha crassa—Sow.

Pteroperna plana.

Trigonia costata—Sow.

———— *striata*—Sow.

Brachiopoda.

Rhynchonella subtetrahedra.

No. 3.—The *Ostrea-bed*, consists of a coarse brown ferruginous sandy marl, interstratified with inconstant layers of ragstone. The fossils are most abundant in the sand. This bed is about one yard in thickness, and contains,—

Conchifera.

Ostrea flabelloides—Lamk.

” ” var. *a*.

” ” var. *b*.

” ” var. *c*.

———— *pixiformis*—Wr. n. sp.

Pecten demissus—Goldf.

Lima proboscidea—Sow.

———— *Etheridgii*—Wr.

Gresslya abducta—Phil?

Pleuromya tenuistriata—Ag.

Pholodomya Heraultii—Ag.

———— *ovulum*—Ag.

———— *media*—Ag.

———— *Davalqui*—Lyc.

Monotis tenuistriata—Wr. n. sp.

Annelida.*Serpula grandis*—Goldf.**Echinodermata.***Clypeus Michelinii*—Wr.*Stomechinus germinans*.

No. 4.—The *Marl-bed*.—Beneath a thin band of clay underlying the “Oyster-bed” is a soft mud-stone which is only exposed at one or two points at the south end of the quarry; it contains many fossils with the shell preserved, but with the test in such a rotten state, that only a few species could be determined. From the position of the bed, and from its organic contents, it appears to be the upper part of the Oolite Marl, as this rock is in position and well-developed, within 200 yards of the “Rolling-Bank.” The following fossils were there noted:—

<i>Chemitzia</i> sp.	<i>Nerinea</i> sp.	<i>Modiola plicata</i> Sow
<i>Pecten lens</i> Sow.	<i>Cypricardia cordiformis</i> Desh.	
<i>Terebratula Etheridgii</i> Dav.		<i>Montlivaltia</i> sp.

From this Section it therefore appears that the *Humphresianus* beds at Cleeve Hill rest upon the Oolite Marl, and are capped by the Lower Trigonina Grit. The equivalent of the zone is only partially fossiliferous at Charlton Common, Leckhampton, Shurdington, and Cooper's Hill. Doubtless if the rocks were worked the characteristic fossils would be found. For the grand development of the beds composing the zone of *Ammonites* *Humphresianus* the student must proceed to Dundry Hill where they are admirably exposed and richly fossiliferous, being capped by the beds forming the zone of *Ammonites Parkinsoni*, and resting on a thin bed of Upper Lias Sands.

In Somersetshire and Dorsetshire the middle division of the Inferior Oolite is likewise well developed and exposed. •

With these notes by Dr. Wright I will bring to a close the question of the “Roadstones” of Cleeve Hill, the position of which may now be looked upon as definitively settled, all our local geologists having assented to the position laid down by the Secretary and Dr Wright. This was the problem proposed for solution at our Cheltenham meeting, and it has drawn forth an amount of learning and research most creditable to the Geologists of our Club. It is in the elaboration of such local details that we can best serve the cause of science; and it seems to me most desirable, that keeping that aim in view, we should direct our attention as much as possible to special points of local difficulty and interest, whereby we shall be setting before us an object, the careful elucidation of which cannot fail to stimulate our individual energies, while at the same time it will secure well-merited honour to the Scientific Society to which we belong.

The next Meeting of the Club was held at Newnham, on the 13th of July.

The first point visited was Westbury Cliff, which has lately been carefully examined by the Secretary and Mr. Lucy, who have noted a section differing so materially from those already published, that by permission I will proceed to incorporate it in this resumé of our proceedings.

Section of Garden Cliff, Westbury, by J. Jones and W. C. Lucy.

Upon the Green and Red Marls of the "New Red Sandstone," dipping 2° S.S.E., which are here exposed to the depth of 70 or 80 feet, rest conformably :—

- 1.—A band of hard black Shale in which we first find coprolites which appears to be identical with those of the bone-bed above 2 feet
- 2.—A band composed partly of grit and partly of iron pyrites, its weathered surface exposing many teeth, coprolites, and shells of *Pullastra arenicola* .. 5 "
- 3.—Black Shale, like No. 1 2 "
- 4.—Band like No. 2, with *Pullastra arenicola* ... 8 inches
- 5.—Black Shale as Nos. 1 and 2 2 feet
- 6.—BONE BED, consisting chiefly of Pyrites, containing fine specimens of teeth, coprolites, palates bones, &c. 1 inch
- 7.—Black Shale as before, with coprolites, &c. ... 6 feet
- 8.—Pecten-bed 2 inches
- 9.—Black Shale 4 feet
- 10.—*Pullastra* bed 1 inch
- 11.—Shale 9 feet
- 12.—Grey nodular limestone of uncertain fracture, containing abundantly in places *Estheria* ... 1 foot
- 13 Clayey Shale 1 foot
- 14.—Limestone band containing, at its lower portion, a *Myacites*, probably *M. liassinus* of Quenstedt, and above *Monotis decussata* in great numbers. Brodie says also *Cypris* plants, *Cyclas*, and fish-scales ...
- 15.—Greyish blue Clay 2 feet
- 16.—*Bottom-bed* with *Modiola* and *Ostrea minima* ...

Although not traced at this particular spot, from other Sections in the neighbourhood, it is known that the beds distinguished successively by *Ammonites planorbis* and *Johnstoni*, *Ammonites angulatus*, *Bucklandi*, *abtus*, *oxygnotus*, and *raricostatus*, and *Pentacrinus tuberculatus*, occur in due order, and accompanied to a great extent by the same fossils which are found in each of these beds of the same relative age in Germany.

The considerations arising from an examination of the preceding Section are of great interest, and suggest a subject for

investigation to which the Cotteswold Club may advantageously apply itself. As we have already seen in the case of the junction-beds between the Lias and the Inferior Oolite, so we see here exemplified, those mixed characters partaking of the features of two contiguous formations, which renders it very difficult to draw a line of demarcation, and to assign to each its exact share in the beds in question. Looking merely to mineralogical character, a casual observer would at once place his finger on the well-marked line of junction, where the "Red Marl" is opposed in strong contrast to the dark overlying clays in contact with it, and would, without hesitation, allot the one to the Trias, and the other to the Lias. But an examination of the fossil contents of the beds, as enumerated above, will lead to a very different conclusion.

The *Bone-bed*, which occurs about the middle of the series, is charged with vertebrate remains of a decidedly Triassic character; though in many localities the vertebrate remains of the bone-bed continue upwards in part into the blue stone of *Ammonites planorbis* above, and are even found in a separate liassic bed. Fossil remains of a similar type are met with at Westbury in the lowest band of the dark clay in immediate contact with the "Red Marl," and they are traceable upwards in the beds numbered 2 and 7 respectively. With No. 7, which immediately overlies the *Bone-bed*, we lose all further traces in this Section of these peculiar records of vertebrate existence, and after the interposition of eight feet of clay, the lighter colour of which may perhaps vindicate a mineralogical change in the circumstances of its deposition, we arrive at a very remarkable band which is characterised by the presence of *Estheria*, and from that circumstance is designated the *Estheria-bed*. This fossil, which was formerly considered to be a bivalve Mollusk, and as such received the appellation of *Posidonia minuta*, is now transferred to the Entomostraca, though with some doubts as to whether it be correctly referred to that Order of Crustaceans. Should such be the case, it may possibly suggest for it a freshwater habitat, a circumstance in some degree supported by the discovery by Mr. Brodie of *Cypris*, plants, and *Cyclas* in the limestone-band No. 13 which overlies it.

In the Journal of the Geological Society for November, 1856, Mr. Rupert Jones writing upon *Estheria minuta*, observes that, "Although the recent *Estheria* is a Marine Crustacean, yet since very closely allied forms are of fresh water habits, and since among bivalved Entomostracans, different species of a genus, and even the individuals of a species, occasionally live either in marine or in fresh water, there is no certain evidence afforded by the fossil in question whether the so-called Triassic deposits in which it is found were formed in rivers, lakes, or seas." According to Mr. R. Jones different species of *Estheria* are met with in

Devonian rocks and in those of the Carboniferous, Liassic, Oolitic, Purbeck, and Wealden. Nevertheless he is of opinion that "Although occurring so constantly in the different geological periods from the Devonian to the Wealden, and again in recent marine and fresh waters, yet it is in the Triassic deposits of England and the Continent, and in the plant-bearing beds of Virginia and Central India, that this little bivalved Entomostracan appears to be pre-eminently abundant, so as to serve probably as a faithful index of a peculiar geological horizon."

To the *Estheria-bed*, succeed about four feet of Clayey Shales, which are followed by the bed known as the *Monotis-bed*. This is one of the most remarkable in the district for the number of shells it contains of this species, in a beautiful state of preservation, with an occasional *Modiola minima* intermixed. The prevailing fossil on the under side of the slabs on which *Monotis* is found, is a *Myacites*, which much resembles, if it be not identical with *Myacites liassinus* of Quenstedt, and is interesting as being the first of that genus and family subsequently so extensively developed throughout the Jurassic period. *Monotis* seems properly to be considered a sub-genus of *Avicula*, differing no more from the species with prolonged bases or hinge-lines, which subsequently take its place, than do the *Meleagrinae* from the *Aviculae* of the present time. Considered then as an *Avicula* it is a form which is known to us in the "Caradoc" and probably lower still.

From a consideration of the foregoing circumstances it will be seen that in connexion with mineralogical characters entirely liassic, we have a zone of life which as certainly appears to have its affinities with the preceding period. How far it may be wholly assignable to the "Trias" as has been done by some competent geologists, may perhaps still admit of question. Many regard the entire zone, comprising on the Continent of Europe a succession of beds not less than 200 feet in thickness, as representing a truly transitional period, and as such entitled to a separate and distinct rank, having analogies with both the contiguous formations, yet strictly assignable to neither. Here at any rate is a field for study and observation which can only be successfully worked out by a careful comparison of the series of beds as displayed in our own county at Westbury, Wainlode, Aust, &c., with the same beds at Binton and other localities in Warwickshire, at Penarth near Cardiff, at Axmouth in Devonshire, and wherever else they may be exposed in the British Islands; and these again must be correlated with those on the Continent of Europe, where a more extensive development illustrated by a far larger series of fossil remains, will no doubt eventually enable geologists to determine with exactitude and correctness, the true value of the beds in the geological scale.

With reference to the upper beds of the "New Red," and in

illustration of what may be done by bringing local knowledge to bear upon particular facts, it may not be out of place here to introduce to the notice of the Club certain circumstances which have of late created a great sensation amongst geologists, and which serve again to warn us against accepting the dicta of even the most accomplished minds as though they were not only unquestionable, but as if it were heretical to question them.

The reptiliferous Sandstones of Elgin, in the North of Scotland, have been long celebrated as furnishing the fossil remains of certain reptiles of which the *Telerpeton elginense* and the *Hyperodapedon Gordoni*, both highly organised reptilian forms are the most notable. These Sandstones have hitherto been attributed to the age of the "Old Red Sandstone" by all geologists, including Sir Roderick Murchison, Professor Ramsay, and Hugh Miller. At the same time, however, there have not been wanting those, who looking to the type of the animal remains, have doubted their palæozoic character, though they hesitated in the face of such concurrent authority to admit their claims to a place in the mesozoic series.

Previous to the meeting of the British Association at Aberdeen, Mr. Charles Moore, of Bath, visited the neighbourhood of Elgin, and from his knowledge of the palæontology and geology of the Liassic and Triassic periods, completely changed the geologic history of these Elgin Sandstones. He discovered, by comparison of fossil evidences, that the so-called "Old Red Sandstones," were in truth attributable with all their contained reptiles and fishes to the age of the Trias, between which and the superimposed Lias, the intermediate junction-beds with the characteristic "bone-bed" are distinctly recognisable.

Upon the announcement of this discovery, the beds at Elgin were visited by the first physical geologists of the day, who have fully recognised and confirmed what the palæontological knowledge and acumen of Mr. Moore, had first afforded a clue to unravel, and I have authority for stating, that Sir Charles Lyell intends omitting the *Telerpeton*, and his companions from the list of Upper Devonian fossils in the forthcoming (6th) Edition of the "Manual."

The reptiliferous beds of Elgin are considered to be the equivalents of the *Rhachosaurus* "Sandstones" of Greenshill, near Shrewsbury, and of the "Waterstones" of Red Marley d'Abitot, and of Ombersley, in Worcestershire.

We will now revert to the proceedings of the Club after leaving Garden Cliff. The next point visited was a small isolated mass of "Upper Ludlow Rock," at the back of Flaxley School, which constitutes the lowest stratum displayed in that vicinity, of those beds, by the upheaval of which, the edges of the Forest Coal-basin have been formed. The "Tilestones" rest upon this boss, dipping inwards conformably, while the "New Red" rests almost

horizontally against their flank, having the same degree of dip as at Westbury, viz.: about 2° S.S.E. It is to be observed, that this point is not noted upon the Maps of the Geological Survey; it has, therefore, probably hitherto escaped the notice of the staff of able and lynx-eyed Surveyors, by whose labours that magnificent national work has been so indefatigably and so successfully elaborated.

Wednesday, 17th of August. The Club met at Swindon; the attendance was, however, but thin, not more than half-a-dozen presenting themselves at the rendezvous at breakfast; of these, the majority proceeded on wheels to Abury, while the geological Section, represented by the President and Mr. Charles Moore, of Bath, the well-known palæontologist, addressed themselves to the geology of the district, which they traced from the quarries in the Portland Oolite above the Town, to the summit of the opposite chalk escarpment at Burdrop Park.

The *dirt bed* in the Swindon quarry, which has yielded a very interesting series of fossils to the persevering industry and intelligence of Mr. Moore, was closely investigated; but it does not yield up its treasures to every casual explorer; and one valve of a *Cypris* was the sole, yet satisfactory result of much laborious examination.

In the course of the evening, Mr. Moore exhibited a beautiful series of minute organisms from this bed, concerning which he offered some interesting observations.

The band of dark sandy clay, marked No. 4 in the Section given in the Memoirs of the Geological Survey, Sheet 34, he considers to be the equivalent of the *dirt-bed* of the Swanage Section, and although he stated that he had as yet found no traces of Mammalia in it; yet he has obtained teeth of *Macelodus Brodiei*, and of other reptiles found in the Purbeck strata of Swanage. But the remains of greatest interest are some minute vertebræ and articulated bones, which Professor Owen has decided to belong to a *perennibranchiate Batrachian*, an Order not previously known below the Tertiary beds.

Cypris is found in the same bed, and one or two species of *Chara*, with other fruits, and also a numerous series of Testacea.

This was a Ladies' Meeting, but I regret to say, that the Ladies did not respond to the invitation conveyed in the printed circulars, to the extent it was hoped they would have done. One only gracing the table with her presence. Let us hope this was due rather to the inconvenience of a somewhat distant locality, than to lack of sympathy with the object of our meeting. The occasional presence of the gentler sex at such gatherings of the Club, as may be favourable to their coming amongst us, should by all means be encouraged, as tending to exert a humanizing influence over the rougher nature of even the most intellectual of philosophers; while the Ladies on their part, cannot fail of

imbibing some portion of the fervour and enthusiasm of the naturalist, at the same time that they derive benefit from the new sources of pleasure and interest opened up to them.

The last meeting of the Club for the season, took place at Cirencester, on Wednesday, 14th of September. The President was absent through ill-health, and is indebted to Professor Buckman for the report which follows:—

The Club met at the "Fleece Inn," Cirencester, but in consequence of the threatening aspect of the weather, few members were present. After breakfast, Messrs. Stronge and Bowly took the party assembled, in their carriages, to the old Church of St. Mary, Ashbrook, where the Norman tympanum of the north door, and a west window with peculiar flamboyant tracery, attracted great attention. Maiseyhampton Church was next visited, where the decorated east window, the sedilia and fine architectural morceaux of the early English period, much interested the ecclesiologists. In the Churchyard, under the south wall, were pointed out some specimens of the Elder-tree (*Sambucus nigra*), much sought after by the country-folks, for virtues supposed to exist in them, as set forth in Mr. Jones's paper upon "Certain superstitions prevalent in the vale of Gloucester," which was read to the Cotteswold Club at their meeting at Tewkesbury, in 1854. Poulton Church was next examined, the east window of which deserves attention. It is an early English 3-light window, plain outside, but with an elegant cinque-foiled hood, internally supported by semi-columns resting upon corbel-heads. A fine Section of the "Great Oolite" and "Forest Marble" was here examined, and explained by Professor Buckman.

After dinner Professor Buckman exhibited some fossil reptilian eggs found in the Great Oolite near Cirencester; and in the absence of papers gave a lecture upon the growth of *Carduus arvensis*, or Field Thistle, setting at rest the disputed point as to whether Thistles grow by seed, by exhibiting a pot in which eight seeds had come up out of ten sown. This furnishes us with some interesting facts in illustration of the history of thistle growth. It is known that these plants spread themselves below the surface by means of *Rhizomata* (underground stems), after the fashion of Couch-grass; and the knowledge of this fact has given rise to the widely disseminated impression that Thistles do not grow from seed. But this experiment of Professor Buckman shews that the seeds readily germinate; and such seeds being of the pappiform kind, and each flower producing about 150, while each plant on an average produces 20 flowers, it will readily be seen at what a frightful rate of increase this plant possesses the faculty of propagating itself— $150 \times 20 = 3000$ for a single plant, which if grown on a waste place may readily distribute seeds over an entire farm.

It will not be out of place here to notice the valuable results

of some further botanical experiments conducted by Professor Buckman in the Gardens of the Royal Agricultural College at Cirencester. The first has reference to the mode of growth of "Flax Dodder" seed, the method of its germination, and how it attacks its foster-parent and establishes itself. This has been made the subject of experiment, and a most elaborate article has been written thereon in the *Agricultural Gazette*. This, together with remarks upon about 200 experimental "plots," will be published in the reports to the British Association, which the Cotteswold Club may be pleased to know has made a grant of *Ten Pounds* towards defraying the expenses of these investigations in the Gardens of the Royal Agricultural College.

The next experiment by Professor Buckman is one of more than usual value and importance, as it has had for its object the ennobling of a wild root; and its complete success is of the highest interest, as bearing directly upon the intricate question of the origin of many of our culinary herbs and fruits, the descent of which, from their wild congeners, has always been a subject of doubt and difficulty, it being by many believed that the wild plant, though cultivated for ever so long, will never produce an esculent variety. The Wild Carrot—*Daucus carota*; and the Wild Parsnip—*Pastinaca sativa*, are amongst those whose absolute specific identity with the cultivated varieties appears to be indisputable, having all the characters in common excepting that of being fit for food. The Carrot, I believe, has hitherto resisted all attempts at civilization, and continues obdurate and intractable; though I do not despair of hearing that under Professor Buckman's superintendence and persuasive manipulation, the refractory nature of the plant has been overcome, and that a new variety of that useful esculent has been added to our list of culinary roots.

With the Parsnip, however, the learned Professor has been entirely successful, and the "ennobling" of Wild Parsnips has this year arrived at such perfection, that a new variety of the root has been established, and the seed of it can be obtained from Messrs. Sutton, of Reading, under the title of "The Student Parsnip," which is reported to be a most compactly formed root, of a clear unbranched outline, and of a fine flavour.

It will not have escaped observation how large a portion of the foregoing pages is dedicated to the records of Geology. This is no doubt a most attractive science. The objects which it embraces are amongst the grandest and most exciting to the imagination to which the intellect of man can apply itself. It has been remarked that Geology ranks next to Astronomy in the sublimity of the facts of which it takes cognisance. Looking, moreover, to the almost perfect development of the geological series in some of its most important epochs, as displayed in this county, and further at the vast bulk of geological history exposed for

investigation, from the "Upper Llandovery" beds at May Hill, to the Coal Rag and Oxford Clay in the neighbourhood of Fairfield, illustrated throughout, in many parts profusely, by a series of fossil organisms, whose numbers and variety seem to increase the more the containing beds are examined—looking, I repeat, to all these circumstances, we cannot feel surprise that so many labourers should be attracted into such an absorbing and exciting field of investigation, and that so few, comparatively speaking, of our number should devote themselves to those other branches of Natural Science, the study of which, though perhaps yielding results less specious, yet forms the foundation of all sound geological learning, and offers to those who will dedicate themselves to the work, prizes at least as great, results quite as important, as those which have conferred distinction upon so many Naturalists from the days of Aristotle to the present time.

A consideration of the foregoing circumstances, and of the extreme desirability of extending the range of subjects of which the Club takes cognisance, induces me, whilst urging the increase of our numbers, to endeavour to establish among us Sections for the more especial study of Zoology and Botany, by whose accumulated labours we might hope gradually to amass a fund of materials, out of which a complete Natural History of the County might one day be elaborated. Such an aim seems to me a noble and a useful one, and one to which the Cotteswold Club may worthily apply itself.

The Botany of the County has found an able expositor in our colleague, Professor Buckman, who, sixteen years ago, published a little Handbook to the Botany of the environs of Cheltenham, which, as the first attempt to tabulate the plants of an interesting historical district, is of great value, and contains, within a limited compass, principles of arrangement capable of being adapted to the illustration of the Botany of the entire County. This is a study which should recommend itself especially to our Lady friends, whose co-operation I would earnestly solicit. It would afford them never-failing interest and pleasing occupation, while, as fellow-labourers with ourselves in the field of local science, they might greatly aid in carrying out the objects we have in view.

The Club numbers amongst its members two or three Entomologists, to whom we may look for good work among the Insects. I have already recorded upon the face of our proceedings the occurrence of the rare beetle *Platyrhinus latirostris*, to which I desire to add a few more Coleoptera worthy of notice which have come under my own observation.

Chrysomela distinguenda—Taken in a great Oolite Quarry, near Sherborne, in this County.

Anobium pertinax—Taken under the bark of a pollard willow in March.

Synaptus filiformis.—*Ctenonychus hirsutus*, Stev.—Hitherto esteemed rare; but taken by me in abundance on the bank of the Severn, in June.

Elater balteatus.

Ptinus imperialis.

Astynomus ædilis.

Sciaphilus muricatus.

Grypidius equiseti.

Of the beautiful and favourite order of *Lepidoptera*, there are many more students than of the less showy and more intricate *Coleoptera*. From one of these, Mr. Bingham, of Newnham, I have received the following notice, which I proceed to transcribe:—

"The Sallows last spring were very unproductive, for although I worked them well, they only gave the common species, such as *gracilis*, *cruda*, *stabilis*, *rubricosa*, &c. In 1858, I took two *leucographa*, and a friend met with *rubiginea*. In April, I took *Leiocampa dictæa* on a gas-lamp, for the first time in this district. In June, the woods were full of life. In company with a couple of entomological friends, 113 species were taken between the 7th and 11th of the month, of which the names were noted, as well as many others in the smaller groups of which we had no knowledge. Amongst those noted, occurred *Eupithecia debiliata*, hitherto supposed to be confined to Devonshire—*Aporia crategi*—*Cherocampa elpenor*—*Euthemonia russula*—*Hepialus velleda* (new)—*Hadena thalassina* (new)—*Hadena W-latinum* (new)—*Thyatira batis* (new)—*Macaria notata*—*Eupithecia pulchellata* and *coronata*—*Acidalia trigeminata*—*Asthena sylvata*—*Minoa euphorbiata*—*Melanippe hastata* and *unangulata*—*Roxana arcuella* (new)—*Semasia Weberana*, &c. Those to which the adjective 'new' are affixed, are new to my local list."

"During the five years that I have imperfectly worked this district, I have taken, within walking distance of Newnham, about 500 species of *macro-lepidoptera*, including the *Tortricinæ*, but exclusive of the *Crambidæ*."

Procris globulariæ.

Sphinx convolvuli.

Acherontia atropos.

Stauropus fagi.

Pterostoma palpina.

Leiocampa dictæa.

———— *dictæoides*—(larva).

Notodonta ziczac—(larva).

Trichiura crategi.

Pæcilocampa populi.

Prodelia literalis—An extremely rare insect, only the second instance of its occurrence in Gloucestershire, the other occurred at Bristol.

Geometra papilionaria.

Ennomos tiliaria.

—— *fascantaria.*

—— *erosaria.*

Macaria alternata.

—— *notata.*

Tephrosia extersaria.

Acidalia fumata.

Harpalyce—All except *picaria* and *sagittaria.*

Collix sparsata.

Asthena Blomeri.

"These are among the more noticeable insects that have come under my observation; and I have no doubt that were the Dean Forest well worked, it would rank with any district in England or Scotland as respects the number and variety of the 'Lepidoptera' indigenous thereto."

I have now, I believe, Gentlemen, touched upon all those matters which seem to me to require notice; and in concluding this address, I will repeat my thanks for the support and assistance so freely accorded me, while at the same time I urge a continuance in that course of energetic perseverance, united with good feeling and brotherly kindness, which has so long characterised the proceedings of the Cotteswold Naturalists' Field Club.

*Address read to the Cotswold Naturalists' Club, at their
Winter Meeting, held at the Royal Agricultural College,
February, 1855.*

By T. BARWICK LLOYD BAKER, Esq. of Hardwicke Court,
President.

THE close of another year, my friends, calls upon me, as your unworthy President, to resign into your hands an office which your kindness, and not my fitness, has continued me in for many years, and which I have hitherto accepted because I did not see clearly how to find a substitute with equal leisure and zeal in the cause. Now the case is altered, and I would seriously ask you to look through your list of members, and see if you cannot find one who, with more youth, activity, and leisure, and with talents really fitting him to preside over your discussions, has, if we may trust to appearances, not less—though certainly not more—good will to the cause than myself. If you can find such a one—and I think it cannot be difficult to do so—and can prevail upon him to accept it—I would most gladly give into his hands one half of my office, namely, that portion of it which appertains to the Presidency—and retain for myself the other portion, which is better suited to my talents, namely, that of helping to find conveyances, endeavouring to find the way in our rambles, reminding the members—most unpleasantly—of the flight of time, and—less unpleasantly—of the approach of the dinner hour.

But, before I resign my office, I must recall to your recollection the sayings and doings, and, I trust, the enjoyings of the past year.

In the first place I must congratulate the Club on the accession of some new names, which—though we are anxious to confine our numbers within certain limits—we cannot but rejoice to see on our list, namely, Dr. Voelcker and Mr. A. Williams, the Chemical and Natural Philosophy Professors of the Royal Agricultural College; The Rev. S. Lysons, a name so well known to the Antiquarians of England, and particularly of this county; The Rev. H. W. Bellairs, the Inspector of Schools for this and several other counties; and J. H. Elwes, Esq., our worthy High Sheriff.

Secondly, I must congratulate you, Gentlemen, on the series of papers which this year have been read at our meetings.

1st, On some Rolled Bricks, from the Channel Islands, by Mr. Guise.

2nd, On the remains of an Ancient Cross, at Ampney Crucis, by Mr. C. Pooley.

3rd, On a New Crustacean, from the Channel Islands, by Mr. Guise.

4th, On the superstitious reverence shewn to Parsley, Elder, and other plants. By Mr. Jones.

5th, On Mammalian Remains, from the gravel, at Stroud, by Professor Buckman.

6th, On some Maltese Echinoderms, by Dr. Wright.

These papers, Gentlemen, are a most valuable addition to our Club. The credit which accrues from them to our Society is a point that I most highly value. Yet still we must remember that

as it introduces a new feature, and in some degree carries the Club from its original unpretending and economical character, it is only right and fair that the point should be fully considered and made the subject of a special vote from the Club, to which I purpose, if you will permit me, to call your attention later in the evening.

To proceed, then, to recall to your recollection the days we have enjoyed as Club meetings this year.

On Tuesday, Jan. 31, the Club met, as now, within the hospitable halls of the Royal Agricultural College, at Cirencester, which, not content with being the most valued seat of science during term time, does not disdain, in the vacation, to give their assistance to the humbler efforts of less regular votaries. After the election of the officers, some valuable papers were read by Mr. Guise and Mr. Pooley; and Mr. Stronge shewed us a curious growth of a root whose spongy texture had entirely choked a drain at, I think, a depth of four feet; the natural history of which was ably commented upon by Mr. Buckman.

An examination of the College Museum occupied the time till dinner, after which we had a long discussion on the memorial Window proposed to be erected to our valued and lamented member, Hugh E. Strickland; and the Revs. H. R. Barker, W. Symonds, and F. Bayley, and Mr. Jones and Mr. Buckman were appointed as a committee to select a design.

On Tuesday, May 9, I was prevented by yeomanry duties from attending; but I am informed that the Club met at Gloucester, and after breakfasting at the Spread Eagle, proceeded in a barge to the Upper Lode, stopping to examine Wainlode Cliff, below which, the Severn being low, the dredgers succeeded in finding the following fresh-water shells:—

Ancylus fluviatilis.

Paludina vivipara.

Nerita fluviatilis.

Pisidium amnicum, of an extraordinary large size, and

Lymnæus stagnalis.

Unio tumidus.

” *auricularius.*

At Deerhurst Church the capabilities of the window destined to receive the glass memorial to our lamented associate, Hugh E. Strickland, was inspected, and the proposed design exhibited; and the members present came to an unanimous decision that the early Saxon remains of this most interesting church—probably the oldest of the county—should be faithfully copied and embodied in the records of our Club, while they remain in their present intact and complete state of preservation.

This decision of the Club appears valuable, and well worthy to be carried out. I know not whether any steps have been yet taken in it, but if not, I would propose that some of our members—shall I suggest Mr. Jones and Mr. Buckman should be requested—if they will kindly undertake it—to make a report to the Club at a future meeting.

In the course of the day Mr. Buckman pointed out the low range of hills receding from the west side of the river, and remarked

that they are capped with sand and shingle, curiously marking the boundary of the estuarine period of the broader river. The present stream was observed to have made its way through alluvial beds, which, at the place of embarkation, are sufficiently tenacious for the making of bricks, for which purpose it is largely employed. The men at the pits said that they frequently met with the bones of large animals, perhaps Elephant, Hippopotamus, Rhinoceros, and Deer, which were the inhabitants of these isles long ere Brutus, grandson of Æneas—as the unquestionable authority of Geoffry of Monmouth informs us—landed on them and gave them the name of British.

Mr. Guise's and Mr. Jones' papers finished the proceedings of a good day and a large meeting: many members of the Malvern Club having joined the party.

Tuesday, June 14, had been fixed for a gathering of the four Clubs of this part of England, at the Speech-House, in the Forest of Dean. We breakfasted at Newnham, where we found awaiting us a specimen of that peculiarly hideous fish the *Lophius piscatorius* (Wide-gab fishing frog, or Sea devil), caught in the river a few days before. We then walked over the Bailey, and followed the line of the Railway to Cinderford, through most interesting sections of the Old Red Sandstone, Mountain Limestone, Millstone Grit, and Coal, all lifted up at high angles of inclination, sometimes as much as 61 degrees.

Hence to Lightmoor Colliery, where, in addition to a noble steam engine, we were shewn a most ingenious and valuable contrivance to obviate the effect of the occasional negligence of the engineer, by which the truck of minerals just raised from the mine is occasionally drawn over the pulley, to the great danger both of machinery and human life. In this machine, when the truck approached too near the pulley it was caught and remained suspended, while the rope, detached from it at the same moment, might be carried harmlessly round and round the barrel.

A peculiar blight upon the Forest Oaks, at a distance, was so observable as to give them quite an October aspect, but we did not approach sufficiently near to examine them minutely. Mr. Buckman is disposed to think that it was not a blight, but arose from the circumstance that the first leaves of the oak buds came out early, and soon changed to a dark hue, and then to the autumnal tint. The buds then, in the middle of summer, took a fresh growth, and you had the varied tints arising from prematurely old leaves with an unusually new state of young leaves. This was very general last summer throughout England. However this may be, Sir James Campbell, the Ranger of the Forest, has since told me that he has often seen the same in former years, both in this and other forests, and the effect on many trees which he has annually measured, has been that, in the years when thus affected, they have not grown in size at all.

At the Speech-House, about seventy persons sat down to dinner—half being members of the Cotteswold Club and friends—

the remainder being members of the Worcester, Woolhope, and Malvern Clubs. Mr Jones exhibited a beautiful series of *Rhynchonella subdecorata*, from the inferior oolite, a species erected by Mr. Davidson, from the examples now shewn; and the *Arbacia Forbesii*, a rare Echinoderm, from the Gryphite grit.

Mr. Atkinson, Deputy Gaveler of the Forest, exhibited some curious plans of the coal and iron mines of the district; and Mr. Herbert Mackworth gave us much interesting information on the fire-damp, and exhibited a variety of apparatus for testing its presence, observing particularly on the almost necessity which exists for a higher state of education and intelligence in those workmen who have the charge and care of mines.

A member of the Worcestershire Naturalists' Club announced the interesting discovery in his county, during the past year, of *Carex montana* and *Potamogeton flabellatus*.

On Tuesday, July 11, the Club met at breakfast at Minety Station, and then broke into two sections—the one to examine the Railway cuttings, of which the President and Secretary formed part, and there turning off to Braydon Pond, about a mile from which, close to the high road, was a curious specimen of one of the ancient elms of Lydiard Forest. The trunk, about 25 feet in circumference at six feet from the ground, rose from a tangled and almost solid mass of roots, which, as near as I could measure it, was 21 feet long by 15 feet across.

What was seen by the other section, who, under the guidance of Mr. Bowly and Mr. Taylor, went on an antiquarian expedition to the Market-place and Abbey of Malmesbury, we know not, as no report was given us.

I would venture to suggest, as a rule of the Club for the future, that whenever the Club breaks into sections, some one be appointed as Secretary for the day with each section, who shall be requested to draw up a short report of what has been seen for the next meeting.

On Tuesday, August 8th, we again essayed, in spite of our failure of weather on the former occasion, to persuade Ladies to honour us with their company at Cirencester. This time the weather was most fortunate, and the day was thoroughly enjoyable and enjoyed. After breakfast we proceeded in flies and other vehicles through the Park, stopping to look at the noble Cathedral Firs, and then driving on to the Edgeworth Valley, we rambled and scrambled through it; finding, amongst others the following interesting plants:

Asperula cynanchica.

Vicia sylvatica.

Hippocrepis camosa.

Dipsacus pilosus.

Orchis ustulata.

On a rocky side of the valley, facing the south-west, was found a pretty natural collection of ferns, consisting of

Polypodium calcareum.

" *vulgare*

Aspidium filix mas.

Ostea fragilis.

Asplenium trichomanes. *Scolopendrium vulgare.*
 " *Adiantum nigrum.*

Returning by the old house of Pimbury Park, with its fine terrace of yew trees, we dined, to the number of 70 in the Woodhouse. Papers—none were forthcoming; but the toast to the health of the strangers, was responded to by the Hon. General Watson Webb, now of New York, but whose ancestors were of our own county; and Mr. Buckman gave us some most interesting and amusing details of his recent American tour.

On September 12th, the Club, contrary to all but irrevocable decree, accepted the invitation of the Earl Ducie to breakfast and dine at his hospitable mansion at Tortworth. The day was most auspicious, and while Lord Ducie most ably acted as Geological pioneer, led one section through a fine geological country embracing the trap rocks, Silurian, old red sandstone, and mountain limestone of the neighbourhood, a second section roamed through the Park, along the walks, round the lake—now being opened out and restored to order—by the entrenchment, which still bears the ominous name of Bloody Acre; by the site of the Vineyard, which flourished at no distant period (though of the flavour of its wine we have no accurate record); by the Lover's Leap, the pens of Circassian Deer (*Cervus Wallichii*); the kitchen gardens, close to which is a remarkably fine *Auracaria*; and then, crossing the road, to the Court, where the Chestnut, described as "The Old Chestnut," in the days of king John, still grows broad and green, a noble specimen of antiquity; while near at hand a considerable variety of Pines, amongst them a remarkably fine *Insignis* and *Sabineana* attest the improvements which latter years have made in giving variety in colour and form to the landscape.

After dinner, several papers were read, particularly one by Dr. Wright, on a number of Echinoderms, collected in Malta by our noble host, and which forms a prominent feature in our forthcoming number.

And now, Gentlemen, before I release you, I must touch upon a few other matters relative to the year which has passed since our last winter meeting.

I cannot but allude to the loss which the cause of science has sustained in the death of Professor Edward Forbes, of whom it has justly been said, by Professor Buckman, He will long be remembered as a *genius*; as a naturalist, who, while he could well trace distinctive characters, was not a mere species maker: this his thorough acquaintance with morphological views, and the great physiological facts connected with both plants and animals, kept him above and beyond. His mind was that of the great but not fanciful generaliser. In Natural History, indeed, he was a *Philosopher*, not a mere collector.

Another point you must allow me to mention, is that of the new number added, or being added, to our transactions. It is one of which we may justly be proud, but I must also remind you

that it is one which entails upon us a considerable expense, and although I for one should be glad to see the expense still farther increased by an increase of such papers—still, as it was not contemplated in the original formation of our Club, I think it right to bring the matter fairly before your consideration.

It appears to me that three courses lie before us. First—to print *all* such papers as may be read, even at an additional increase of expense, yet still amounting to but a small sum per annum if regularly collected. Secondly—to limit ourselves, as was originally intended, to matters connected with the Natural History of the County. And, Thirdly, to make an arrangement by which any members might subscribe for any number of copies they might wish for, and so divide the cost according to the number of copies ordered. This matter, Gentlemen, I beg to leave in your hands—reminding you, however, that the unprecipitated call of one pound each is made this year—it is in fact for the transactions of this year and last, as nothing was collected last year.

Though I, however, should be sorry to limit our papers strictly to county matters, yet I confess I should be glad to see these more closely followed up. We have as yet no list of Fossils, Plants, Shells, or Insects, any of which would form a most desirable and appropriate feature in the works of our Club; while of our numerous and interesting antiquities, with the exception of Mr. Pooley's paper of this year, not a word has been said save the simple record that the Club has visited them, as given in the address of your most unscientific President. Forgive, Gentlemen, my calling your attention to this subject. I am, as you all know, a man of few ideas beyond my county, and though I should be sorry to see the transactions of the Club strictly limited to the field of our rambles, yet I cannot but think that we should more especially fulfill our mission, as a County Club, by devoting more attention to the Natural History and Antiquities of our own district.

Notes on the Natural History of the County of Gloucester.

By Professor J. BUCKMAN, F.G.S., F.L.S., &c.

ON THE ORCHIDACEÆ.

The Orchids present such a large assemblage of highly curious plants, that it seems astonishing so little should be popularly known about our native examples. It is true that a few species of exotic Orchids may be met with in the hot houses of the more wealthy, and these are esteemed on account of the strange forms which their flowers frequently assume, and the exquisite perfume some of them exhale. But though it is quite true that these have had their share of attention, yet who in a country walk at home ever plucks an Orchis, much less examines its structure, and yet they abound everywhere, and offer a showiness of flower, a variety of colour and structure with, in some species, an odour which

should make them general favourites. The Primrose, the Cowslip, the Hycacinth, and other of our wild flowers, find their way into the cottage garden, but we never yet saw an Orchis in a cottage garden or taking part in a rustic nosegay; however, great heaps of the commoner ones may occasionally be noticed laying prostrate by a stile or scattered about the country childrens' play-ground, having been gathered by the little unsophisticated creatures who have always a deep love for "pretty flowers," which, in as far as the Orchis is concerned, is early destined to be clouded by a prejudice which, in after life, is so strong as not merely to lead to indifference, but to a positive superstitious dread of these beautiful and harmless creations.

This feeling would appear to have been derived from the name, which country people apply to some of the commoner species, namely, that of "Bloody Man's Fingers;" no doubt applied on account of the digitate roots which are white and fleshy, and bear no distant resemblance to bloodless fingers; and yet, curiously enough, this form of root is not common to the commoner species as the two everywhere met with, the *Orchis morio* and *O. mascula*, have two rounded tuberous appendages below the surface of the soil, which contain so much starch as to make the plant by some be considered as worthy of cultivation.

Little however as these plants have been attended to as objects of floral culture yet they will be found well worthy of notice in this respect, to which end field specimens should be marked when in flower for removal in the autumn, a remark necessary inasmuch as the usual plan of taking up flowering roots when first observed, usually results in disappointment in these, as it would be the case with most plants when in full flower. Of course observation of the locality, soil, and habit of growth, would conduce greatly to success.

The following is a list of all the species which I have met with in our County. These are 18 belonging to 8 genera, being somewhat more than half the genera belonging to the British Flora, as described by Hooker and Arnott, and nearly half the species, the numbers being of total British species 38 appertaining to 14 genera.

List of the Orchidaceæ of Gloucestershire.

1. *Epipactis latifolia*, Broad-leaved Heleborine.—In the woods in Oakley Park, Cirencester, Birdlip, and most of the Cotteswold woods and thickets.
2. „ *grandiflora*, large white H.—Plentiful in Oakley Park, and in the north Cotteswold woods, but no where in the Vale.
3. „ *ensifolia*, narrow-leaved white H.—A few years since I met with two specimens of this plant beneath the Rookery trees of Oakley Park, and not deeming but there would be others, I at once appropriated these examples of an exceedingly rare plant to my Herbarium, but alas, the most diligent search for years has not again given me sight of a living specimen. It may

well serve as a curious subject of enquiry as to how it came there, and may illustrate how easily a plant may become extinct in any given locality.

4. *Listera ovata*, Twayblade.—Common in our woods.
5. „ *nidus-avis*, Bird's-nest Orchis.—Common under the beeches in Oakley and other woods. Having taken up specimens of this plant, with their curious bunches of nest-like roots, I cannot at all agree that it is parasitic, as is usually supposed.
6. *Neottia spiralis*, Ladies' Traces.—The only locality in which I have met with this plant, in Gloucestershire, is in a grass field on the south slope of Marl Hill, near Cheltenham. This field, from its regular ridges, had evidently once been in tillage, and yet it seems an isolated example of a pasture with us containing this plant, which, at the time of my visit, some 15 years since, was very abundant in this habitat.
7. *Orchis Morio*, Green-winged Meadow Orchis.—Too common in pastures, in which its great abundance may betoken poverty of soil, as it is usual in "cold hungry clays."
8. „ *mascula*, Early purple Orchis.—Common to rough meadows and low thickets.
9. *Orchis ustulata*, Dwarf dark-winged O.—I have met with occasional examples on Sevenhampton Common, near Cheltenham; at Eyford, near Stow-on-the-Wold; and on the slope which descends from Dunsburn into Edgeworth valley.
10. „ *latifolia*, Marsh O.—In damp marshy meadows, frequent.
11. „ *maculata*, Spotted O.—Common to woods and thickets.
12. „ *pyramidalis*, Pyramidal O.—In Oakley and other Cotteswold woods and thickets.
13. *Gymnadenia conopsea*, Fragrant Gymnadenia.—Occasionally met with in Oakley, Uley, and other woods and thickets of the county, well distinguished by its lilac coloured flowers and fragrant scent.
14. *Habenaria bifolia*, Butterfly Orchis.—Common in the Cotteswold woods. This is also a highly fragrant species.
15. „ *viridis*, Green H.—At Charlton, near Cheltenham, and Furzen Leaze, near Cirencester.
16. *Herminium Monorchis*, Green Musk Orchis.—This I have only met with in one locality, namely, on the slope of Ravensgate Hill, below Linover wood, where it forms a rounded bay, looking down upon the village of Charlton.
17. *Ophrys apifera*, Bee Orchis.—This beautiful specimen has been met with, more or less sparingly, in several habitats. I have gathered it on Painswick Hill, on Leckhampton Hill, and very fine examples in Oakley Park. The most curious locality in which I have met with it is on a spoil heap thrown out in making the Thames and Severn Canal, by the Engine-house near Tetbury road Station.
18. *Ophrys muscifera*, Fly O.—In Lineover Wood, Charlton Kings, and in the woods bounding the north side of Sapperton Valley, but only sparingly.

*Address read to the Cotteswold Naturalists' Club, at their
Winter Meeting, held at the Royal Agricultural College,
Cirencester, January 30th, 1856.*

By T. BARWICK LLOYD BAKER, Esq., of Hardwicke Court,
President.

FOR ten years, now, my friends, you have borne, without any serious resistance, the tyrannical sway of your President. During ten years the Club has increased in size, strength, and importance, and has seen others and similar clubs rise on all sides around it. But while you have grown from infancy to strength, your President has grown from strength to—if not absolute weakness—at least to considerably less strength, and feels not unfrequently so overwhelmed by his work (which would be mere play to many men) that he has this year paid far less attention than he was wont to the duties of his office; and had it not been for the zeal and attention of the Secretary, the business of the Club would, I fear, have been altogether neglected.

Do not, I pray you, misunderstand me, and suppose that my interest in the Club has diminished—on the contrary, there is hardly a day in the year that I enjoy so much as that of our Cotteswold meetings. But work of a most engrossing and absorbing interest has so much increased upon me of late, that my study of nature in general has of late contracted almost entirely to that of the genus *puer*—species *fur*.

Still, unfit as I am for the task, I cannot refuse at our annual meeting to give such account as I can, either—from what I myself had the happiness of seeing, or, far better for you—from the descriptions given by others who were present when I was obliged to be absent.

On Jan. 30, 1855, such members of the Club as did not object to early hours were hospitably entertained at breakfast, by the Principal of the Royal Agricultural College, at Cirencester, who has so often and so hospitably entertained us before. Having examined the Museum of the College, and been much gratified by the additions which we found, we adjourned to the Library for our business—discussion incident to this one meeting of the year.

The following resolutions were then passed, and we hope they may have resolved themselves ere this into facts. We will “pause for a reply,” after reading each resolution, to enquire how far this may be the case.

It was resolved, then, first, that Messrs. Jones and Buckman should be deputed by the Club to examine Deerhurst Priory, and make a report on the remains of that most interesting relic of antiquity, to be printed at the expense of the Club.

Resolved, secondly, that Messrs. Lycett and Buckman be requested to examine into the present mode of the publication of

the proceedings of our Club, and to report on the best plan to be adopted for the future.

I trust we may be fully assured that both of these matters have been fully considered, as the first is a point almost touching the honour of our Club, while the latter touches its private interests.

The President and Secretary were then re-elected, and the meetings for the ensuing year were fixed.

A paper was read by Mr. Lycett, on the *Perna Quadrata*; and another on the bones of Beaver, Deer, &c. found in Nailsworth valley. And by Professor Buckman, "A notice of the Oxford Clay, as found near Cirencester."

After dinner, in the hospitable Hall of the College, an animated discussion on that most interesting of topics—which has the great advantage of being an unceasing ground of battle, inasmuch as no two people can ever be brought to take the same view of it—viz. the nature and value of species—would no doubt have lasted till the crack of doom, had it not been far more agreeably cut short by a summons to tea.

On May 1st, although we make a general rule not to accept the hospitality of any of our members, further than an occasional and rare invitation to breakfast, yet we made, I may almost say, our one exception, and spent most of the day at Apperly Court, the seat of our kind friend, Henry Strickland, Esq.

After examining the beautiful specimens illustrative of different branches of natural history, and looking over the exquisite drawings of plants, by Miss Strickland, the members proceeded to Deerhurst Church, both to enjoy again the beauties of the Norman—or in part, as some hold, Saxon—architecture; and also to see the window of stained glass (by O'Connor) which our Club has been allowed to assist in putting up, in commemoration of our sincerely lamented friend and associate, Hugh E. Strickland, Esq.

Much satisfaction was expressed by the subscribers who were present at the manner in which their wishes had been carried out.

On returning to Apperley, the Club was entertained at dinner by Henry Strickland, with his usual hospitality; and if some sad thoughts intruded, we at any rate felt thankful to be allowed to meet again the family of one whom we had so loved and regretted.

June the 12th was appointed for a meeting of the Worcester, Malvern, Woolhope, and Warwickshire Clubs, with our own, at Malvern.

Yeomanry duties prevented my attendance, but, as I learn, the geologists, under the distinguished guidance of Sir Roderick Murchison, and the botanists under that of Mr. Lees, proceeded to the Warwickshire Beacon, where Sir Roderick delivered a most eloquent lecture on the geological formation of the country around that magnificent spot; after which Mr. Lees explained the principal features of the botany of his own loved hills.

The dinner, under the presidency of Sir Roderick, was most numerous attended, and the guests speedily adjourned, by the invitation of the ladies, to coffee, after which Mr. Buckman read a paper on one of the forms of *Terebratula* (*T. perovalis* var. *ampla*).

I do not know whether I may have been much to blame on many former occasions, for promoting discussions between the members of the Club. I certainly have often done so, and have greatly enjoyed the exhibition of the talent and knowledge that these discussions have called forth. Alas! must this pleasure cease—must we check at once all shew of a difference of opinion, for fear that it should degenerate into animosity? Can we not hear an opinion, even contrary to our own, expressed, without imputing an intentional wrong?

The meeting, alas, terminated with a feeling that a somewhat uncomfortable had occurred, and with an idea that for such small and unpretending affairs as ours, meetings of a moderate size were preferable to *very* large ones.

August 28th, the Club should have met at Berkeley, (so says Mr. Jones, to whose kindness I am indebted for the following able report,) but Purnell B. Purnell, Esq., having invited the most constant attendants of our meetings to Breakfast at his residence, the "venue" was laid at Stancombe Park, instead of the Berkeley Arms, whither, accordingly the Club repaired. Antecedent and posterior to, the usual commencement of the proceedings, that is a hearty and well-provided breakfast, in which Ladies were allowed to participate, some of the treasures of that Gentleman's collection were thrown open to inspection, the variety and costliness of which surprised many. Although not a professed geologist, rare specimens varying from all the specimens in his neighbourhood to the Mammalian Crag, invited the attention of the geologists of the party; and although not a professed antiquarian, the collection of personal ornaments of the Egyptian, Etruscan, Greek, Roman, and Medieval periods will not soon be forgotten by those who gazed with interest only, upon relics connected with the social progress of the human species.

The delight with which the party traversed the tastefully laid out grounds, can only be indicated, but not conveyed. Here a subterranean passage, opening out into one of those bursts of sylvan scenery which the "cwms" of the Cotteswolds alone can parallel. There a small classical building, replete with treasures of ancient art, derived from all the people already alluded to, and not excluding the wonders of Nineveh and Babylon. Here a pond, dilated by the exquisite taste which dictated its construction into all the landscape effect of a lake; there a receptacle of the rarest stuffed birds, paintings, models of fishes and fruits, from the universal Exhibition of 1851, and paintings of esteemed old masters, which divided attention with the artfully set scenery

revealed through the narrow strips of pure crystal in the stained glass windows. In various paddocks were seen Kangaroos, the Apis Deer, and other rare creatures disporting themselves, while in the park itself, enjoying perfect freedom, and upon terms of the most perfect familiarity with their visitors, ran a small herd of Llamas.

After spending some hours most agreeably in the contemplation of this beautiful spot, the Club adjourned to Berkeley, whither its members were conveyed and accompanied by their kind entertainer, and where dinner was served. After dinner Dr. Wright read a paper upon some unique Echinoderms of the Oolites, of which he exhibited specimens. Mr. Lycett had brought with him an exceedingly interesting series of *Gryphaea dilatata*, for the special purpose of correcting certain heretical opinions of our Secretary, Professor Buckman, but it appeared from the reports of some of his Cirencester neighbours that he was "not in condition," and consequently Mr. Lycett did not bring his paper forwards, and, much to the regret of "the fancy," there was "no fight."

In the absence of the President and Secretary, the chair was taken by the Rev. J. S. Haygarth, who, in addition to the usual toasts, proposed the health of the President and Secretary of the Club.

Those members who were dependant upon the train for home transit, were kindly driven there by their host of the morning, P. B. Purnell, Esq., thus terminating one of the most delightful days of which record has hitherto been placed upon the annals of the Club.

Sept. 25th, at Birdlip, as usual, a large meeting took place, a great point of attraction being Crickley hill, the interesting fossils of which locality, though picked up for the thousandth time, seem never to tire. Here the great height to which the Upper Lias creeps up the scarp, which latter bears such evidence of ancient water action, was commented upon by the Secretary, by whom the following section of Crickley hill was taken:—

	ft.	in.
1. Soil	0	8
2. Rubbly oolite (debris)	4	0
3. Red incoherent calcareous sands	6	0
4. Hard freestone in large blocks (building stone) ...	15	0
5. Pisolite, with but a slight admixture of oolite ragstone	5	0
6. Freestone, including pisolite & parted by seams of do..	9	0
7. Hard block of oolite, consisting in part of very indurated pisolite	35	0
8. Sandy oolite, containing large blocks of ragstone, occasionally very pisolitic, as traced to the outcrop..	25	0
Total...	99	8

Notes.—Twenty feet of bed 7, consists of 7 layers of hard stone, some of which are as much as 3ft. 6in. in thickness, these are parted by thin seams of oolite sand. This rock presents also a fine example of the smooth-faced “lissens” of the quarrymen. The blocks of stone include large specimens of Lima, Gervillia, Belemnites, &c.

It will be seen that here is nearly 90 feet of rock more or less pisolitic at the point where the section was taken, namely, nearly in the centre of the Crickley hill scarp, below the Roman encampment.

Along the line of the slight dip of these beds, below the “Air Baloon” public-house, these are superimposed by a coralline bed, which has been erroneously pointed out as oolitic marl.

After partaking of alas! too sumptuous a dinner, at the Black Horse, the health of *Dr. Lanza*, of Spalato, was drunk with cordiality, when a paper was read by *Dr. Voelcker*, on the Chemistry of Recent Roman and Fossil Bones, with an addendum on the Mineral *Apatite*, which has lately been largely imported from Norway, and was referred to as likely to become of importance to agriculture, from the large percentage of *phosphorus* which it contains. Any discussion, however, upon this valuable and interesting paper, so nicely illustrated with specimens of fluoric acid etchings, together with all chance of any other paper, was at once put beyond all hope by a debate upon the dinner bill, which, alas, somewhat abruptly terminated our Summer Meetings.

Inundations in Antient Corinium.

By Professor JAMES BUCKMAN, F.L.S., F.G.S., &c.

“When found, make a note of.”

THIS injunction of the worthy Captain Cuttle, as its frequent quotation testifies, is capable of most extensive application; and if it be made to apply to our ordinary discoveries, where we find out a use for this or that, or indeed to any truth that is patent to us, to make a note thereof, not only fixes the matter in our memory, but it furnishes us with a storehouse of knowledge for frequent examination and comparison, like that which is presented in a Geological Museum or in the *Hortus Siccus*. In all cases these scraps are so many specimens, which in their single selves may tell us much, but conjointly may add to our knowledge in an ever increasing ratio.

It often happens with our notes as with our specimens, that a few slight conclusions may at one time be drawn from them, when suddenly, from the addition of a new truth or a new specimen, things that before were nearly idle, assumed a new life and

shape; and so, instead of acquainting us merely with the power and functions of A and Z, arrange for us all the letters between, and thus make out for us a consistent alphabet.

We have been led to make these remarks from having made extensive notes upon Roman remains in Corinium, during the progress of which appearances were observed, and methods of construction were demonstrated to have been adopted, for which there presented itself to us, until within the last few months, no sufficient solution. However, recent atmospheric phenomena have of late supplied the required note—the connecting link; and though the resulting conclusions are not perhaps of grave importance,—yet, as they not inaptly show the value of our friend the Captain's dictum, we shall at once give them a place in our proceedings.

In all the diggings yet made, proximity to our Roman pavements is at once manifested by a thin stratum, varying from three to six inches, of fine well washed gravel. Sometimes this gravel is hard and compact; partially cemented together, it would appear, by lime either in solution or suspension in water, or perhaps both; and the walls of the chambers have occasional markings around them, which seem to indicate the presence of standing water, at different periods, to different heights.

Now, this gravel is for the most part that which entered into the composition of the wall cement, added to which the finer particles of stone in the soil would have a tendency to sink lower and lower until arrested by a hard impassable stratum.

In many instances where rude concrete pavements have been formed, plastered walls have been noticed even below the bottom of the floor; while in the more general examples the concrete for wall and floor is continuous.*

In another case we had an arrangement in which the floor—a tessellated one—was raised on a solid concrete foundation, considerably above the bottom of the plastered and even frescoed walls, leaving what appeared a deep channel or drain all around the room.

Again, in digging the foundations for the houses at Watermoor (Chesteron Terrace), Roman masonry and a vast mass of reliquia of the same period was arrived at, much of which has been carefully preserved, and is now in the Corinium Museum.

It was on account of the loose materials collected here that the new foundations were dug to a considerable depth, during their whole progress exposing work of perhaps sixteen centuries previously; and in this digging, at the south end of the Terrace, two distinct floors were exposed, one above the other, in the section, at a distance of as much as four feet apart. Between the upper and lower floor was a filling up of rubbish, of which broken

* In this, the other examples adduced, we are sorry we cannot introduce our sketches, as these would doubtless explain the matter better than words.

bricks, bits of pottery, and gravel, formed the general mass. This is by no means uncommon here, as it often happens that one floor has been formed on the top of another, and at varying distances apart.

Now the season of 1852 was one of unusual wet, and Cirencester, like other places, was then inundated with water, and an examination of Roman sites in this place demonstrates that the antient floors, like too many of our modern ones, was just then below the water level, and even at Chesterton Terrace there was nearly a foot of water in the cellars, the floors of which are a little below the level of the lower Roman floor just adverted to; so that the upper floor would be entirely out of the way even of a much higher inundation than the present one, whilst a few inches more of water would have also covered the lower one. From these notes, therefore, we seem justified in drawing the following conclusions :—

Firstly—That Corinium, like Cirencester, suffered from occasional inundations, and that the occurrence of one floor above another in our Roman works, show how the antients remedied the inconvenience,

Secondly—That these inundations were even deeper in antient than in modern times. This we shall have no difficulty in understanding, if we consider the greater facilities these days offer for carrying off water by draining and other improvements.

And, lastly, many of the appearances about our Roman sites seem to show that excess of water has been oftentimes repeated during the last fifteen hundred years, though at very distant and irregular periods.

NOTE.—*The Notes upon which the above Paper was founded were principally made in the wet season of 1852.*

*Annual Address to the Cotteswold Naturalists' Club,
January 27, 1857.*

By Professor JAMES BUCKMAN, F.L.S., F.G.S., F.S.A., &c.

IN order to account for my presence before you at this period, it will be sufficient for our members to be told that, the President had requested me to prepare the annual address for this meeting. We all know how his slightest wish is *law*, and how attention to his laws has usually resulted in benefit to our community; if therefore the present instance of obedience to, and respect for, his high commands should end in disappointment, pray cut *me* up as much as you please—but, for our President, I only hope he may consider me a sufficiently *juvenile offender* to warrant him in extending towards me his philanthropic support and protection, when, in all probability, I shall by next year be so far reclaimed as not to venture upon the like offence again.

Before reviewing the proceedings of our past session, I would call upon you to pay a tribute of respect to our departed associate the Rev. H. J. Bolland. I need not speak to you of his goodness of heart, of his kind and gentle manners, of his keen perception of natural beauties, qualities for which he was endeared to every one who had the good fortune to know him; yet I may say that, though no professed natural historian—no classifier of genera or species—yet was he a naturalist in the best sense of that term, as he was a lover of *nature*, who could draw from *her* contemplation abundant proof of God's Wisdom and Power, and the book of Creation was, in his hands, not a hindrance but a graceful help to the lessons drawn from the one he was ordained to teach.

The few secessions of the past session have been filled up by the election of Mr. Pierson, of Cheltenham, who will long be remembered for the active part he took (in conjunction with our talented associate Dr. Wright) in supplying and arranging the beautiful Geological Museum to which the British Association was welcomed at the Cheltenham meeting. An addition has also been made to our ranks by the election of Mr. G. F. Newmarch, solicitor, of whom it may be said that although his profession obliges him to pore over other *deeds*, even drier than the species list of the geologist or botanist, yet he chooses the study of nature as his relaxation, and to this end we hope he will frequently join the ranks of our field rambles.

In reviewing the field proceedings of the past session, I shall have to refer you to our places of meeting, premising that in no former year have we experienced a more regular attendance of members; and if, on review, it be found that our papers have not been so numerous as on former occasions, it could only arise from the always too brief interval between dinner and the departure of the train being amply and profitably filled up either in comparing notes of the ramble of the day, or in the discussion connected with some matter or object introduced by the members.

To begin with our annual meeting in this place, on the 29th of January last year. I find it recorded that after partaking of the hospitality of the Principal of the College, in the shape of a hearty breakfast, the Antiquarians visited the Corinium Museum, the tessellated floors of which had just been laid. On this occasion a hearty cheer greeted the noble Earl Bathurst, as a spontaneous thank-offering for his liberality in rearing so substantial a building for the protection and preservation of these works of the past. To-day you were again invited to visit this Museum, and I feel sure again to pay the tribute of respect, as since last year his Lordship has liberally allowed me to furnish the Museum with the necessary cases, &c.; and at present we have seven handsome oak and glass cases, in which are arranged upwards of a thousand objects relating to the Roman occupation of the antient Corinium and its neighbourhood; these I feel assured you were struck with, not from their intrinsic value, nor from their beauty of form, though there is much that is striking in this respect, but from the many articles they contain of domestic use; a circumstance which you will understand if you examine a plan (suspended on the walls) of the dwellings which I excavated in 1852, as in these rooms were found the Statue of the Deity and his Altar. The living room with its valuable fictilia, some so prized as to have come down to us with the rivets by which its antient possessor had kept together its fractured portions; its ornaments of *armille* and *fibulæ*, as perfect in form as when they first formed a tribute of affection or a sign of ostentation. The dividers (compasses) of the draughtsman—the shears, which did duty as scissors to the Roman matron—and the oyster knife, so like our own as to show us that we have now no better mode of opening the “refractory bivalves,” as Albert Smith calls them, than was to be found as much as 15 centuries ago. These, with cutlery, together with the hone-stones upon which it was sharpened, have only here been referred to, to show that the Collection of Antiquities in the Corinium Museum is particularly valuable as explaining to us some facts connected with the inner life of this interesting people, whilst, at the same time, we should feel thankful to them for having introduced to, and left among us, so many articles tending to advance our civilization.

Pardon this digression—if, as Mr. Bowly would say, we have been pursuing the wrong fox, we were soon led in the right direction by the Noble Proprietor of Oakley Park, who headed us through the park glades until we joined the Agricultural party at his Lordship's new farm buildings; here the whole machinery was set in motion by the powerful engine completed last year, and the Geologists examined the well-sinking through the Great Oolite into the Fuller's Earth, a depth of 140 feet. The whole of this shaft was carried through beds of a more or less porous oolite, without a break either lithological or palæontological, a circumstance which gave rise to some discussion between Mr. Hull, of the Ordnance Geological Survey, and the Secretary—the

former gentleman considering a large portion of the shaft as representing the Forest Marble, the latter considering it as wholly belonging to the Great Oolite, and contending that certain clay beds, which occur higher in the series, where the true Bradford Clay is absent, present a natural division and one which can be carried out through a wide extent in this district. At a later period of the meeting, the Secretary presented a section of this well with others of the neighbourhood, and read a paper on the Geology of the water-bearing beds about Cirencester.

Having transacted the usual business of the Club, the members and friends, to the number of 40, sat down to a substantial dinner, which, from its abundance and small cost, was certainly a convincing proof that our dinner bill need not be extravagant when we have a liberal landlord to deal with; at the same time we must bear in mind that our long rambles make us good trenchermen, whilst our moderation in imbibition tends much to limit the usual profit, so that we may not wonder in these days of dearth that, even at the Lamb at Cheltenham, a petition was preferred after our last dinner there for additional pay.

Well, dinner over, after the usual toasts, and one to the health of the re-elected President and Secretary, followed by that of Professor Ramsay, the Director of the Ordnance Geological Survey, who honored us with his presence, a paper was read by Dr. Wright, on the section of Frocester Hill, the object of which was to show that a certain bed at the base of the Inferior Oolite, and formerly referred to that rock, should, in the Doctor's opinion, be held as part of the Lias; this view was supported by a reference more particularly to various Cephalopoda, (principally *Ammonites* and *Belemnites*), most of which are peculiar to the bed itself, whilst others are such as belong to the Upper Lias, and at this meeting was introduced the *Ammonites bifrons*, which was triumphantly pointed out as proving the case; and indeed so startling was the production of this shell, as I understood from the bed in dispute, as in a great measure to stifle discussion upon the subject until the matter had been further looked into; and herein we have much to thank the learned Doctor for in directing our more particular attention to one of the most interesting sections in our county. The result, however, of my own labours at Frocester Hill, leads me to conclude that the *Ammonites bifrons* in question was obtained from a bed nearly 80 feet below what has been held to be the basement bed of the Inferior Oolite (the *Cephalopoda* bed of Dr. Wright), and as much as 20 feet from the top of the Upper Lias, and consequently that distance below the Inferior Oolite Sands of the Ordnance Surveyors. However, as this subject came before us at the Painswick meeting and again at Cheltenham, I shall shortly refer to it in another part of this address, only pointing out that the mistake is easily made, inasmuch as the steep scarp at Frocester has long been exposed to the action of the atmosphere, and hence its included iron has become

so oxidised as to render the clays and sands much of the same colour, and besides the upper sands have slipped down the slopes and become intermixed with the upper beds of the Lias.

The business, then, of our last College meeting concluded with the Secretary calling attention to a Section extending from the Vale of Gloucester, below Birdlip, along the Roman Road to Stratton St. Margarets; this, which was the result of the joint labours of our then Professor of Engineering, Mr. Armstrong, with a Class of Engineering Students, and myself with a Geological Class, had been carefully worked out in an Easter vacation; and I have at this meeting the pleasure of introducing to your notice another section, done in like manner, extending from the College through Moreton-in-Marsh to Shipston-on-Stour, in Worcestershire. The great interest of these Sections is that they have not been made hypothetically, but are the result of a systematic and combined survey, the Engineers taking the levels of the country surveyed, whilst the Geologists marked the strata, collected fossils, noted facts connected with quarries, wells, and the like, so that we hope these Sections may be satisfactorily appealed to for settling some important practical questions.

I cannot conclude my remarks upon matters connected with this meeting, and more especially in the presence of ladies, without referring to the charming wind-up of the day—and a most agreeable one too—afforded by an invitation to Mrs. Haygarth's tea-table. This kind lady evidently understands the natural history of naturalists, a fact which you will recognise more keenly when you know that the meeting of to-day resulted in the wish of Mrs. and Mr. Haygarth.

May 20.—The first summer meeting was appointed for the Painswick district, and we have to thank the managers of the Great Western Railway for depositing us at Haresfield, from whence we took the ascent of Beacon Hill, carefully examining the section there presented; ascending to the quarry we pass over an interesting fault, and at the very brow of the hill the strata have been washed away and the chasms filled up with oolitic debris and shingle, the former offering an example on a small scale of an undercliff, caused by subsidence resulting from the wearing away of the Oolitic Sands and Upper Lias by the Severn Sea, and the latter the result of that shingle deposit which may be traced along the Cotteswold scarps, as so cleverly pointed out by Mr. Hull. During this ramble we examined all the beds of the Inferior Oolite, being much assisted herein by the use of a beautifully detailed Section, worked out by our accomplished associate, Mr. Jones, and which, with his permission, I hope to publish in our proceedings.

June 17.—Mitcheldean was the place appointed for this month's meeting, and as I could not attend, I have to thank Mr. Jones, not only for making the necessary arrangements, but for a full

and most comprehensive report of the proceedings of the day, which I am sure you will thank me for giving you *verbatim et literatim*.

"Leaving Gloucester at 10.24, the party, consisting of Lord Ducie, J. H. Elwes, W. V. Guise, D. Bowly, and myself, and J. R. Wilton as a visitor, receiving the welcome addition of the Rev. W. S. Symonds, at the Grange, duly arrived at the Mitcheldean Road Station.

"The ascent of the Lea Bailey was immediately commenced, and the upturned edges of the Carboniferous Limestone, with its shales speedily found exposed for examination in the most satisfactory manner, and dipping from this position towards the centre of the forest basin, S.S.W., at an inclination of about 20 degrees. The Limestone appeared to contain very few fossils, but the shales yielded some slabs of a thin band of stone composed almost entirely of the shells of *Serpula* and *Spirorbis*, and of *Murchisonia*, and other small Gasteropods, interesting from the very great abundance in which they occurred. From this point the same stratigraphical line was followed to the neighbourhood of the Hawthorns, where, in a deep road cutting, may be seen the finest section of the transition beds between the Old Red Sandstone and the beds above mentioned, to be found in the district; no better could, in fact, be desired, from the high angle at which the beds are exposed. Descending the hill from the cutting to Drybrook, where the innermost of the two seams of coal laid down on the maps of the survey as below, or rather, at this point, outside the Grits which form the basin bed of the true coal measures is worked, the shale was found to be particularly rich in well preserved coal plants of the usual character. The vein of coal, locally known as the Coleford High Delf, was described by the miners as about five feet in thickness, of a quick burning quality, containing much sulphur, and therefore principally used for lime-burning and like purposes.

"The shaft open before us, was stated, upon the same authority, to be carried about seventeen hundred yards under the Grit which forms the bulk of the hill above it. Some sixty to seventy feet of this stone, which is familiar to all of us under its economic aspect of 'Forest paving,' is well exposed in a quarry immediately above the shaft, but the entire thickness of the stratum must be very much more considerable. These slabs, throughout their whole depth, as far as my observation extends, are more or less rich in impressions of *Calamites* and other plants, although these are probably more abundant in the lower than in the superior layers. An old quarryman here took some kindly interest in us, though manifestly sorely puzzled what to make of our pursuits and designs. He appeared finally to conclude that we were railway men, and was at some pains to point out to us the precise direction in which a certain projected 'stem road' was to go, and which has progressed to the point of having been, in Forest phraseology, 'dialled and pegged off.' (I consider the quaint conversion of

'theodolite' into 'dial' worthy of passing mention.) Discovering at this point that dinner, according to time, must be nearly ready, all faces were turned towards Mitcheldean, where at the George it awaited us.

"So much for the Geological section; and much it rejoiceth me to say, that I can upon this occasion refer to another which has not been heard of in the annals of the Club for many long days. Mr. Guise and your unworthy scribe, assisted by Mr. Wilton, devoted themselves principally to the entomology of the day, and verily their exertions were not all unrewarded. The Fern-chaffer (*hiatus* for *swell* name, which escapes me at the moment), which is, like all his tribe, in some years exceedingly rare, and in others exceedingly 'de trop,' is this year very abundant.

"While halting in one of the openings in a woody lane, to admire the novel scenery—the Malverns, the Clee Hill, the Sugar Loaf, the Black Mountains, and other distant and unfamiliar eminences, which stood out in the distance with truly remarkable distinctness of outline and feature, an insect of unusual style of flight suddenly attracted the attention of scribe, and disappearing was by him, asserted to have taken refuge with Mr. Wilton, who, on his part disclaimed all knowledge of the stranger, or any desire to be converted into a sanctuary, nevertheless scribe was right, and detected in a fold of his coat a fine specimen of *Silpha quinque-costata*, the third he had seen in our district, both the others having been taken on May Hill. It here occurs to me 'passim' that this is the only *Silpha* I have ever taken upon the wing, and all three specimens known to me were so taken, while all its cousins must be sought for under stones, carcasses, or other effluvious matter, although there can be no more doubt of the necrophagous scavenger habits of the species in question than of those of its congeners.

"Another beetle of the same tribe was very shortly afterwards taken, which is also not very common in our vale, *Oiceptoma ruficollis* and *Oteniceras pectinicornis*.

"I leave Mr. Guise to give his own account of the moths and other insects captured by him. On the summit of Mitcheldean Hill, in the attempt to capture some water beetles, it was found that the shallow mud of a small pond was literally one living mass of the *Pisidium pulchellum*. *Cicindela campestris* was here found in great force.

"The dinner was such as to call forth special encomium, and I really think would have contented, whether for variety, quality, or cost, any member of the Club, which is paying Mr. Yearsley, the host, no mean compliment.

"The Earl Ducie, in the absence of our President, took the head of the table, confronted by W. V. Guise, Esq. The Queen having been duly honoured, the Rev. W. S. Symonds read a paper in part explanatory of the Geological sections examined during the day, and called attention to the discovery in strata of the

Alps, of presumed Triassic age, of *Orthoceratites* and *Belemnites* together, forms hitherto supposed to have been widely separated in time and distinctive of systems, of which each was considered to be one of the most remarkable organisms.

(See President of the Geological Society's anniversary Address, in the *Geological Quarterly Journal*, May, 1856, page lxxi-lxxviii.)

"These are 'hard lines' for those who will persist in drawing them, particularly when taken in connection with a proposition of Mr. Alfred Wallace (referred to in the same Address, page cxiii.) 'That every species has come into existence coincident both in space and time, with a pre-existing closely allied species.' Although Mr. Hamilton, the President, remarks that he thinks 'It may be doubted whether this assumed law can be maintained as a universal generalization,' this is a question which has not been and *must* be fairly worked out, and must therefore long remain an open one amongst Geologists and Palæontologists who are *worthy* Members of such Associations as ours, who humbly, reverently, and conscientiously, venture to approach the veil of the Shrine of the Great Designer, as nearly as the traces of His presence in His works, as revealed to their limited capacities may lead them, however distasteful the attempt may be to those, with whose little theories (the inflating power of their 'bubble reputations') it may interfere.

"Let us pray' that *we* may be enabled to attach less importance, in all our undertakings as a body, to the gratification of petty conceits and personal vanities, the exhibition of mere low cunning and grumbling astuteness, than to the philosophical contemplation, the truthful appreciation, and thankful admiration of the works of the Creator.

"I fear I have somewhat Germanized some of my sentences, but really have not time to revise them, which pray excuse.

"At the dinner table our members were augmented by the presence of Mr. Lysons and party, who had met us at Drybrook.

"After the usual amount of pleasant discussion and interchange of ideas, a delightful day closed, and each one 'went to his place.'

"I ought, perhaps, to have inserted elsewhere in my report, but mention here, that an exceedingly good specimen of an *Astacus*, found by Miss Slatter, in the Great Oolite, of Stratton, near Cirencester, was exhibited by myself."

July 15th, 1856.—Journey to Avebury.—A small party, including the Rev. Canon Powell and Mr. Thomas Warner, met to breakfast at the Swindon Station Hotel, whence proceeding to the hospitable residence of the Rev. H. Light, after inspecting the many objects of interest he so kindly introduced to our notice, we wended our way to the far-famed Avebury Circles. Here Mr. Light having first made a ground plan of the Circles, marking both the existing stones and places of the absent ones, we were by this—assisted by the Rev. Gentleman's tact and local know-

ledge—enabled most clearly to make out the form of this ancient monument.

Silbury Hill, said to be one of the largest artificial mounds in the world, was then ascended by most of the party, and on returning to the village, the church—in which the rood-screen is the most interesting work—was carefully inspected, by which time it was found that the dinner hour had arrived.

After partaking of a well-served repast, Mr. Light offered some conjectures as to the manner in which the Avebury stones had been placed in position, which brought on a most animated conversation.

The Secretary then explained their Geology, and showed how portions—boulders—of the same rock had overspread the country nearly as far as Cirencester; in his short exposition he also took occasion to point out the physical features of the Upper Oolites and the succeeding Chalk Terraces, at the same time explaining the different agricultural practices to which these had given rise; and thus concluded a most pleasant and interesting day, which was rendered all too short in order to be in time for the inexorable train.

It may be interesting to know that the Avebury mounds afforded, among others the following plants:—

Hippocrepis camosa, Horse-shoe Vetch.

Asperula cynanchica, Quinsey Wort.

These plants are interesting as electing to grow on lime rocks, making however no distinction between Oolite, Chalk, or Mountain Limestone.

Orobancha major, Tall Broomrape, an interesting plant, here mostly parasitic on Thistles.

Oniscus acaulis, Stemless Thistle, with—anomalous as it appears—stems several inches high, and presenting complete bunches of flowers. This is one of the forms which has given rise to the many synonyms by which the true species is surrounded.

Whilst on the subject of plants, I may mention the discovery of *Anacharis Canadensis*, in Cirencester Canal. I saw the first specimen of this plant in the fresh-water Vivarium of the Rev. J. C. Thring, and on recognising it I was informed by him that he got it from our canal; here I went in search of it, and succeeded in finding a large patch about 200 yards from the Cirencester head of the canal.

August 15th, Meeting at Cheltenham.—A party of 16 gentlemen met at the Old Imperial Hotel, from thence adjourning to the temporary Geological Museum, at the Philosophical Institution, when having examined the beautiful series of fossils—mostly of the district—therein contained, they wended their way to the great scarp at Leckhampton Hill.

Here they were enabled to make out the following section of the basement beds of the Inferior Oolite:—

	Feet.
1. Roestone (Buckman), Shelly Oolite of Brodie ...	
2. True Pisolite, Pea-grit... .. about	10 0
3. Coarse-grained Oolite, containing much Silicious matter	18 0
4. Foxy-coloured Ferruginous Oolite, very Silicious to bottom of quarry	20 0
	48 0

This, which I had then no means of accurately measuring, I find to approximate so nearly with Mr. Strickland's detailed section, as given in the 6th vol. of the *Journal of the Geological Society*, that I am induced to think the section as now exposed reaches very nearly to the Lias; at all events when I saw the Lias and Oolite in contact at this very spot there was a sudden and abrupt transition from the Oolite to the Lias, there being at this place none of the Inferior Oolite Sands of the Ordnance Surveyors.

In reference to the basement bed of the Oolite, I quote from Mr. Strickland's paper the following remarks:—

“(7) Ferruginous beds, consisting of coarse Oolite in the upper part, and of a very peculiar large-grained Oolite or Pisolite (‘Pea-grit’) in the lower. A few miles to the south the Pisolite disappears, and is replaced near Painswick and at Haresfield Hill by strata containing ferruginous oolitic grains in a brown paste. This is the precise equivalent of the well known Oolite of Dundry, near Bristol, which may be recognized as far off as Bridport, on the Dorset coast. At Leckhampton the Pisolite rests upon a few feet of ferruginous Oolite and Sand; the total thickness of this portion of the series is 42 feet.”

The observations here made, coupled with a somewhat lengthened examination of these lower Oolite beds, both north and south of Leckhampton, induced me to venture to suggest to the meeting of the Geological section of the British Association, and again to our Cotteswold brethren at Leckhampton Hill, an opinion that the Silicious oolite, by which the Pisolite at Stow, Winchcomb, Leckhampton, and Crickley is underlaid, was the representative in time of the Oolite Sands of the Stroud and Painswick districts, an opinion which I am still inclined to favour; however, the details of this matter would be much too long for an address like the present, but I still hope to be able to find time to arrange the material I have got together on this subject before the close of the present session.

To recur to the doings at this meeting. At Leckhampton the party was joined by two ladies who kept up well with the field Naturalists along the top of Leckhampton Hill to Hartley Bottom and the Seven Springs.

Returning by way of Charlton Common and the Sandy Lane,

the agricultural gentlemen expressed themselves highly delighted at the improvement made in the Southfield farm by Sir William Russell, Bart.

It should be mentioned that on the top of the hill was found for the first time the *Caucalis daucoides* (Bur Parsley), probably introduced with foreign seeds in the cultivation now so rapidly spreading in this direction.

At Hartley Bottom the *Thesium linophyllum* (Bastard Flax), was met with in its old habitat, but it appears to be getting more scarce year by year.

The dinner was served at the Lamb, in good style, and our always loyal Club having done honor to the health of the Queen, next followed that of the strangers, which was responded to by Mr. Babington, the eminent botanical author.

The Rev. P. B. Brodie read a paper on the comparison of the Upper Lias Fish bed of Warwickshire, with that of our own county, which will be published in the next fasciculus of our proceedings.

A paper followed by the Secretary, on an abnormal growth in a Cedar tree from Oakley Park, which gave rise to an interesting discussion, in which the President took occasion to notice other curiosities in the growth of trees that had come under his notice.

Dr. White introduced to the attention of the meeting a curious ball which had been discovered some years since at Slymbridge, and figured and described in the *Journal of the Archaeological Institute*; this it is proposed to further describe in the proceedings of our Society, to which end Dr. White promised to obtain the engraving if possible. An interesting discussion took place on the probable use and meaning of this curious relic, in which the President, Mr. Babington, Mr. Rumsey, and the Secretary took part, and with this terminated a most agreeable meeting.

Sept. 9th.—The last meeting of the past session took place at Stroud, when a large party of the members and friends accepted the kind invitation to breakfast of our much respected and hospitable associate, J. G. Ball, Esq., and if a kind welcome, good cheer, and hearty greeting of field companions, be capable of doing good, each must have felt himself better for that morning spent with Mr. Ball and his amiable family; the "sweet sorrow," however, of "good bye" became imperative, as an omnibus was announced to be in readiness to convey us to Frocester Hill—up hammers, bags, and vasculums, and the party is off. Arrived at this famous section, the Geologists gathered new stores to back their discussions, and though one might imagine that they are going to fight, from the strange words they make use of in their arguments, yet we need never be afraid, as after all they do not throw the fossil itself into your teeth, but only its name.

The section at this place, which is an exceedingly interesting one, I hope to publish at some future time, but do not give it here

as I have not yet made an admeasurement with instruments, which I expect soon to do.

Advancing into the wood at the top of the hill, our President observed on the scrubby oak trees some galls, which proved to be those of the *Cynips quercus petiolata*, which could not have been introduced into our county more than two years. A few weeks after I found the same thing very sparingly in Oakley Park, and perhaps at present the park is the furthest easterly limit to which it has attained.

In the arable on the same hill was found several specimens of the *Avena fatua* (Wild Oat), which were taken to the hotel for comparison after dinner with specimens introduced by the Secretary from the College Botanical Garden, when he announced the fact of having produced two types of cultivated oats, viz. the *Potatoe* and *Tartarian* forms from the *A. fatua*, the result having been attained in five years, a circumstance of great agricultural interest, inasmuch as farmers had long maintained that in some land *cultivated*, degenerated in the *wild*, oat, which is one of our most troublesome weeds. Upon this matter experiments are still going on, and no doubt further facts of interest will be elicited in another season.

The dinner at the George was a nice affair, no paper however followed, as the time was fully occupied in discussing the Frocester Hill section, and indeed the proceedings terminated all too soon, train time obliging us to close the meeting somewhat abruptly.

And here, too, ends the *resumé* of our proceedings for the past session, from which, I think you will agree with me, we may safely conclude that in no former year have we had to record better meetings, they have been uniformly characterised by a good attendance, in which kindly feeling and earnest work have ever prevailed.

I cannot conclude this Address without referring to the important scientific gathering which took place in our county during the past year—I refer to the meeting of the British Association at Cheltenham—and while it must be gratifying to our Club to know how successful that meeting was, being indeed one of the best of this important scientific body, it will be doubly so to find the marked respect shown by that august assembly to our little band of naturalists; for while many of our members held important posts in the different committees, for which they were so well thanked both by the Association and the Town of Cheltenham. The Museum of Geology, got together by Dr. Wright, Mr. Pierson, and the Rev. R. Hepworth and others, will long be referred to as the best of its kind to which the British Association was yet ever welcomed.

It was my intention to have given an analysis of the different Natural History papers read at the Association, but I find that this Address is even now sadly longer than usual, and I shall therefore only just mention a few with which we are more immediately concerned.

Experiments in the Botanic Garden of the Royal Agricultural College.

Paper by Dr. Lankester on the Water at Cirencester.

Geological papers, by Messrs. Wright, Ramsey, and Hull (of the Ordnance Survey), Brodie, Etheredge, Moor, and myself; these will be found reported in the Transactions of the British Association; and as regards the experiments in the College Garden, they are being continued in an augmented and careful manner, and in obedience to the recommendation of the Committee of Section C., will be duly reported upon at the request of the General Committee of the Association at the forthcoming Dublin Meeting.

Brief Notes on Cirencester High Cross.

Read at a Meeting of the Cotteswold Club, Sept. 16th, 1856.

By CHARLES POOLEY.

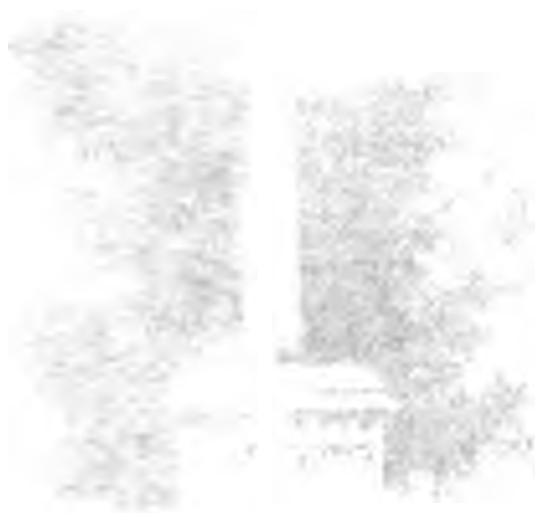
As recently as the year of our Lord 1800, there existed, in the town of Cirencester, the vestiges of no less than six ancient crosses.

These structures, I have ascertained, were distributed over the town, and occupied the following positions:—

One stood in the open part of Dyer-street, where the pig-market is now held; another was placed in the Churchyard; a third, occupied the point where Sheep-street crosses Castle-street; a fourth was built near the southern extremity of the borough, hard by a stream of water running at the end of Dyer-street; a fifth marked the spot where Cricklade-street crosses Leuse-lane; and a sixth, called the High Cross, and which is the subject of this paper, was erected opposite the Ram Inn, in the Market-place.

The march of improvement, which has destroyed many of the picturesque gables of the old town, has also swept away these ancient relics, one after another, and with the exception of the last, not a fragment of either remains to reward the search of the archæologist. For the High Cross, however, though removed from its former site in the Market-place, a better fate has been reserved, a pretty situation having been found for it near the Wood-House in Oakley Park, the seat of the Earl Bathurst, where it forms a worthy object of attraction to visitors.

In *Rudder's History of Cirencester* is the following description of this cross:—"The High Cross stood upon a base of about ten feet square, with four steps on each side gradually diminishing from the lower to the uppermost. From the middle of the base rose an octangular column or pillar, supporting a capital which was much defaced and broken, but it appeared to have been ornamented with carvings, of which the subject could not be distinguished. It is supposed, however, to have been a very curious piece of workmanship, as more than ordinary care had been taken to preserve what remained of it. It was encompassed with an



the first of these is the fact that the majority of the population is still illiterate. This is a serious obstacle to the progress of the country, as it prevents the people from understanding their own needs and the needs of the country. The second obstacle is the lack of capital. The country is poor and has no money to invest in its development. The third obstacle is the lack of technical knowledge. The people are not trained in modern methods of agriculture and industry. The fourth obstacle is the lack of organization. The people are not united and do not work together for the common good. The fifth obstacle is the lack of a strong government. The country is divided into many small states, each of which is ruled by a different prince or chief. This makes it difficult to carry out any large-scale project. The sixth obstacle is the lack of a strong military. The country is not able to defend itself against foreign attacks. The seventh obstacle is the lack of a strong navy. The country is not able to protect its sea trade. The eighth obstacle is the lack of a strong air force. The country is not able to defend its airspace. The ninth obstacle is the lack of a strong police force. The country is not able to maintain law and order. The tenth obstacle is the lack of a strong judiciary. The country is not able to administer justice. The eleventh obstacle is the lack of a strong executive. The country is not able to carry out its policies. The twelfth obstacle is the lack of a strong legislature. The country is not able to make laws. The thirteenth obstacle is the lack of a strong judiciary. The country is not able to administer justice. The fourteenth obstacle is the lack of a strong executive. The country is not able to carry out its policies. The fifteenth obstacle is the lack of a strong legislature. The country is not able to make laws. The sixteenth obstacle is the lack of a strong judiciary. The country is not able to administer justice. 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H.E. Robson, del et litho from a Calotype by Charles Poulton.

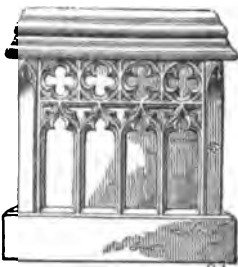
CIRENCESTER HIGH CROSS.

iron collar, from the side of which four bars proceeded to the upper steps, and thus it was supported on the column or pillar of the cross. Over this capital the cross was fixed. The whole being in a very mutilated state, and occupying a large space opposite the Ram Inn, it was taken down about the year 1785."

Brief as this account is, it obviously refers to the cross now standing in Oakley Park, and although since that period it has become still more mutilated, it fortunately retains, in its principal features, sufficient evidence to prove its identity. Assuming it to be a work of the fourteenth century, this cross affords a good illustration of the style of decorative art expended upon these ecclesiastical monuments. It is however by no means perfect. The only part of the original structure which has survived the ravages of time, being the more solid portions, such as the pedestal, shaft, and fragments of the capital.

Differing from the ordinary road-side, or churchyard crosses, which are so numerous in this county, it will be seen that this cross possesses an architectural beauty not at all common in such edifices.

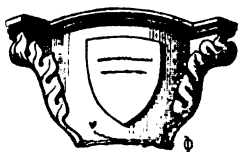
The pedestal is hewn out of a single block of stone, three feet square by two feet six inches in height, and presents on each of its sides, a facade, ornamented with four deeply chiselled gothic arcades, surmounted by pannelled quatrefoils, which are overhung to the extent of some inches by a deep moulded coping. It rests on a plinth which is placed on a heavy basement step, too heavy to be in character with the rest of the building. From the centre of the pedestal springs a remarkably fine octagonal shaft, a solid stone six feet four inches in height and one foot in diameter, having rounded flutings at the angles, and the remains of four broaches at the socket. It is conjectured, by the presence of these broaches, that originally the shaft was set in a smaller block, thus bringing the termination to a square; which supposition would render the design more harmonious, by taking off the apparent abruptness of so small a column rising from so large a pedestal.



With reference to the capital, what remains of it is too much broken and obscured by the growth of patches of moss, to allow the observer to do more than distinguish the mere rudiments of the carvings alluded to by Rudder. But I may remark, by way of example, that on the under side of, and as it were supporting the abacus, there are distinct indications of well-executed carvings of angels' heads and wings, of which the wood-cut gives a good idea; also in



the spaces between the corbels, which project at the four angles of the capital, the remains of escutcheons may be seen, but no trace is left of the emblazonments with which they were doubtless originally enriched. Judging from analogy, and after comparing the Cirencester High Cross with similar structures, I have come to the conclusion that the corbels once supported slender buttresses, which, being arched at the top, formed light canopied niches, in which figures were placed. The ponderous stone in the shape of a cross, now surmounting the capital, is no part of the original design, having been put up some few years ago.



We may infer that in its integrity this cross could not have stood much less than twenty feet in elevation, from the ground to the summit; and some idea may be formed of its handsome character, from the general effect of the chaste proportions of its remains, which are beautiful even in their decay. I have been unable to discover any record from which to determine that this cross was set up to commemorate a particular event.

There is a deed extant, dated A.D. 1413, in which it is called *NOVA CRUX*, which would approximately fix the date of its erection at a period corresponding with its architectural character, which, as before stated, is that of the fourteenth century. Presuming it to have been built just prior to the introduction of the perpendicular style in architecture, or towards the end of the reign of Richard II., we are carried back to the period of the abbacy of Nicholas d'Ameney, or about twenty-six years before Abbot Best procured the mitre for the Abbey of Cirencester, and a seat among the barons for himself and his successors.

List of Birds seen in Siddington, Gloucestershire, with Remarks.

By EDWARD BOWLY.

This List is strictly confined to the Birds seen in the Parish of Siddington; many other varieties have been observed in the immediate neighbourhood. Nearly the whole of the common Birds of prey have been shot in LORD BATHURST'S Woods, where also the Crossbeak and the Greater Red Pole have frequently been seen. A Hoopoe was shot this summer in the adjoining Parish of South Cerney. Phalarope has been shot at Bibury, and the Bittern at Lutton within a few years. Some years since the Royston Crow was always to be seen at Aldsworth, as you travelled from Cirencester to Burford; they are now extinct in that neighbourhood. I have shot the Short-eared Owl when Partridge shooting.

RING DOVE.—Common. Always build in the avenue of lime trees close to the house. Often very numerous in winter.

STOCK DOVE. } Often seen.
 ROCK DOVE. }

- TURTLE DOVE.**—Always to be seen in summer. Breed in our hedges; nest consists of a few twigs, barely sufficient to confine the eggs.
- RAVEN.**—Occasionally seen flying over.
- CROW.**—Common. Breed in the trees adjoining the house.
- ROOK.**—Abundant. Build at the Rectory.
- JACKDAW.**—Always build in the elm tree opposite the Mill.
- MAGPIE.**—Generally breed in the coppice adjoining Cerney road.
- JAY.**—Breed in the coppice beyond the Windmill.
- STARLING.**—Very numerous.
- BUNTING.**—Common.
- REED BUNTING.**—Ditto.
- YELLOW BUNTING.**—Very abundant.
- CIRE BUNTING.**—Very rare, never saw but one specimen.
- CHAFFINCH.**—Very numerous.
- BULLFINCH.**—Common. Often build in the thickest part of the Scotch wild rose.
- GOLDFINCH.**—Common.
- GREENFINCH.**—Very numerous in winter; a few breed here.
- CROSSBEAK.**—Sometimes seen in winter.
- BRAMBLING.**—Not uncommon in severe winters; never breed here.
- BROWN LINNET.**—Common. Breed in the groves, and we have immense flocks in winter.
- SISKIN.**—Only once seen.
- MOUNTAIN LINNET.**—I have shot some of these in the flocks of the common Linnet in winter.
- HOUSE SPARROW.**—Very numerous.
- TREE SPARROW.**—Not uncommon in the winter, but they are principally male birds. I generally shoot some cocks, but very rarely a hen.
- NUTHATCH.**—Not often seen. I frequently see one running up the trunk of a lime tree close to my dining-room window.
- CREEPER.**—I may apply exactly the same remarks as to the Nuthatch.
- WEYNECK.**—Constant summer visitant, arriving about the time of the Cuckoo, thence named by the country people the Cuckoo's Mate.
- GREEN WOODPECKER.**—Common.
- CUCKOO.**—Numerous; the trees above my house a favourite spot with them; during the breeding season they sing the whole night, in all kinds of key.
- GOAT-SUCKER.**—I have seen them two or three summers, but do not regularly visit us.
- SWIFT.**—Common.
- MARTIN.**—Ditto.
- SWALLOW.**—Ditto.
- SAND MARTIN.**—Seldom seen.
- PIED WAGTAIL.**—Plentiful.
- YELLOW WAGTAIL.**—Ditto.
- HEDGE SPARROW.**—Abundant.
- ROBIN.**—Ditto.
- REDSTART.**—Summer visitant, not so abundant as formerly.
- BLACKCAP.**—Same remarks apply.
- STONECHAT.**—Always to be seen.
- WHINCHAT.**—Sometimes seen.
- WHEATEAR.**—Although a constant frequenter of the Cotteswolds, I have never seen but one specimen in this parish.
- GRASSHOPPER LARK.**—Once heard in Furzenlease Coppice.
- SEDGE WARBLER.**—Not uncommon.
- NIGHTINGALE.**—Formerly abundant at Furzenlease, where many were snared and kept the winter in cages; we now have scarcely one in the parish.
- WHITE-THROAT.**—Very numerous.
- LONG WILLOW WREN.** } We have both these.
- SMALLER WILLOW WREN.** }
- CHIT CHAT.**—Frequently heard.

- WREN.**—Abundant.
GOLDEN CRESTED WREN.—Frequently seen in the larch close to the house.
SPOTTED FLYCATCHER.—Always breed close to my house.
SKY LARK.—Very numerous.
TIT LARK.—Common.
WOOD LARK.—Sometimes seen.
LONG-TAIL TIT.
GREAT TIT.
BLUE TIT.
COLE TIT.
MARSH TIT.
BLACKBIRD.
SONG THRUSH.
MISTLE THRUSH. } All inhabitants of our parish; the Blue Tit most numerous.
FIELDPARR. }
REDWING. } Numerous in winter.
PHEASANT. }
PARTRIDGE. } Abundant.
LAND RAIL.—Breed here.
WHITE OWL.—Bred in the large elm near the Mill for upwards of twenty years, but have left four or five years, I believe from the Jackdaws having also taken possession of the tree; we often hear the young Owls trying to hoot, which is amusing.
BROWN OWL.—Often seen.
KESTREL.—Breed here, and is almost the only Hawk we have left.
SPARROW HAWK.—Rare.
HOBBY.—Once seen, some years ago.
GREAT BUTCHER BIRD.—Sometimes seen.
LESSER BUTCHER BIRD.—Generally have two or three pairs in the neighbourhood.
HERON.—Common. I have often seen eight or ten rise in the coppice near the Windmill, and they have occasionally bred here, my man once caught a young one unable to fly far.
LITTLE GREBE.—Breed here.
CRESTED GREBE.—One caught alive on the ice on the canal in the winter of 1854 and 1855; this specimen is now at Overthrow's.
STORM PETREL.—One seen in the Canal after two days of tremendous wind.
GREEN SANDPIPER.—Formerly to be always seen in one spot in the meadows, now not so frequently.
KITTY-WAKE.—Not unfrequently seen flying over. I once shot one so doing.
COMMON GULL.—Occasionally seen flying over. One shot last month, Feb. 1857.
SNIFE.
JACK SNIFE. } Common in Winter.
WOODCOCK.—Always at Furzenlease after the first autumnal rain, and continue the winter.
LAPWING.—Breed here: collect in immense flocks in the autumn and disappear in very severe weather.
GOLDEN PLOVER.—Seldom seen.
COMMON CURLEW.—Three once seen.
KINGFISHER.—Common on the banks of the Churn.
WATER RAIL.—Breed here; not so common as formerly.
BALD COOT.—Only once seen. One caught alive on the Canal, April, 1857.
MOORHEN.—Breeds here, and is abundant in some of our meadows.
WILD SWAN.—Often seen in severe winters; several have been shot.
WILD GOOSE.
WHITE-FRONTED GOOSE. } Often seen in severe winters; several have been shot.
TEAL.—Not uncommon in winter.
WILD DUCK.—Breed in our meadows.

*Address read to the Cotteswold Naturalists' Club at their
Annual Meeting, April 27, 1858.*

By T. BARWICK LLOYD BAKER, Esq. of Hardwicke Court,
President.

AGAIN, my friends, have we met for our Annual Meeting, to review the pleasant gatherings which many of us at least have enjoyed during the last summer, and to plan the excursions which we hope to enjoy in the present year.

Much do I, for my own part, regret that I have been able to attend so few of those of the past season, for slight as may be my knowledge of the sciences so ably followed by many members of our Club, I can safely say that few days in the year afford me so wholesome or enjoyable a relaxation from the work which more and more engrosses me, as the gatherings of the Cotteswold Club. My own lack of knowledge, however, I must supply from the accounts given by others of the meetings, I would fain have described as an eyewitness.

On Jan. 27th, a party of Ladies and Gentlemen met at what we may term our most hospitable head-quarters, the Royal Agricultural College of Cirencester, where, as always, we were most kindly received, took a walk to the Corinium Museum, Watermoor Church, and the City Walls, and returned *for business* to the College.

The said business consisted of the re-election of the President and Secretary, till such time as fitter men could be persuaded to take the offices; and the election of Edward Holland, M. P., of Dumbleton, and David Nash, Esq. the eminent scholar of Syro-Egyptian literature.

At the dinner (happily we had many good things to counterbalance it) was exhibited a jar of the *Anacharis alinastrum*, that most to be dreaded of water weeds, which threatens, if all we hear be true (fortunately for us, little more than half we hear is so) to choke every stream, navigable or not, and every canal in the kingdom, in a very short space of time. This fearfully rapid weed had been found only the day before in the Canal, near Cirencester, and now at the end of fifteen months (which brings us to the present time) we anxiously ask our friends from the neighbourhood of Cirencester, Is the Canal yet passable? Happily, for us, many evils which appear dreadful at first sight, are more bearable when we come to closer terms; and I trust we may find this the case with the *Anacharis alinastrum*.

The Rev. P. B. Brodie also read a paper which we trust to see recorded in our transactions, and the party separated with much gratitude to Mr. and Mrs. Haygarth.

On May 26th, a meeting did take place at Chipping Campden, but, alas, it could hardly be called a meeting of our Club, inasmuch as *our* only members who met there were our worthy Secretary and the Rev. P. B. Brodie, who came less as a member of the Cotteswold, than as President of the Warwickshire Club, who had agreed to meet there on that day. Never mind. While we can boast to have sent out so notable a scion from our Club to found another Club elsewhere—though we may regret that we meet him less often than heretofore—we count him anything but lost.

It appears that the party visited first the Church, and then the mounds left from the working of Mickleton tunnel, where a large collection of fossils were found—indeed most of those described in Mr. Gavey's work—with the addition of a fine specimen of the *Hippopodium ponderosum* (whose existence was questioned by Mr. Gavey), found by the Secretary of our Club, and presented by him to the Natural History Society of Warwick.

On June 23rd, a meeting had been fixed for Winchcombe. A small party met at the Ram, at Cheltenham, to breakfast, and proceeded in flys to the Rising Sun, the summit of the hill on the Winchcombe road. Here they separated: one section proceeding under charge of the Secretary, exploring the earth, found specimens of *Mytilus jurensis*,* *Ter. Phillipsii*, and *T. Buckmani*, amongst other shells of the inferior oolite; while another section, under the charge of W. V. Guise, Esq. searching the air, appear for some time to have caught no species except certain Diptera—a race of diminutive Tartars, the catching of whom is neither profitable nor pleasant. After a time, however, on the eastern slope towards Postlip, Mr. Guise had the satisfaction of taking the somewhat rare and local *Procris statice* (Green forester), with the *Pyrausta purpuralis* and *punicealis*, and found dead in the road (the coroner happily not having sat upon him) a fine specimen of the *Sphinx ligustri*, or Privet Hawk moth. After dinner, a paper was read by Mr. Guise, "On some rare Bats discovered in the county," the specimens illustrative of which were kindly presented by him to the Royal Agricultural College.

In July, a meeting, honoured by the presence of a large number of ladies, again took place at Cirencester, and again formed two sections. The one, under the charge of the Secretary, explored Oakley Wood, where they found specimens of *Epipactis grandiflora*, *E. latifolia*, *Convallaria majalis* in fruit (this locality for the Sweet Lily of the Valley was discovered by Miss Haygarth), and other plants; while others of the Club, under the direction of Mr. Pooley and Mr. Jones, went first to a cornbrash quarry at Siddington, where a very satisfactory series of fossils of that bed

* Dr. Wright maintains that he knows no such species as the *Mytilus jurensis*, but the Ammonite *Jurensis* does not exist in the Inferior oolite.

were found. Thence to South Cerney, the Church Steeple of which had been seriously damaged by lightning, the repairs of which, we trust, may spare the very curious Norman carvings (so resembling those of Quennington as to appear to have been the work of the same artist); and returning by Siddington, where the attention of the section was called to a Norman font, a memorial window of the Langley family, and to the very recent, but, to us who knew him, not less interesting object, the memorial window to the late Rector, the Rev. Henry J. Bolland.

I am glad to avail myself of Mr. Jones's Report of this section.

"Despite the combined attractions of the society of the ladies, the far-famed beauties of Oakley Park, and the *botanical** eloquence of a Buckman, certain members there were who decided upon visiting other localities. Mr. Pooley kindly took these individuals under his charge, and drove them to a Cornbrash quarry, at Siddington, in which a very satisfactory series of the fossils common in the bed were obtained by all—*Acrosalenia hemiscidaroides* by Miss Slatter, and a fine fish palate by Mr. Jones. Two pits in which the Oxford Clay was worked for brickmaking were then visited, but both were found to be exceedingly unfossiliferous, furnishing only young specimens of *Gryphæa dilatata*, *Ammonites Lamberti*, fragments of another small *Ammonite* too imperfect for identification, and one good specimen of the upper valve of *Ostrea deltoidea*. One of the workmen exhibited two good specimens of *Ammonites macrocephalus*, hitherto supposed by English geologists to be a Cornbrash form, but maintained by Dr. Oppel, in his work on the Juraformation, now in course of publication, to be distinctive of the Kelloway group, and not to occur below the grey clay which rests upon the Cornbrash, and, according to his view, forms the basis of the Callovian.

In the ponds formed by the excavation of the brick-clay, the common Stickleback *Gasterosteus aculeatus* abounds, although no connection with any stream or watercourse could be discovered. It was suggested that some ingenious member of the Club might favour it with a paper upon this subject, not a whit inferior in interest to the celebrated treatise on the origin of tittlebats in the Twickenham ponds, by the renowned Mr. Pickwick. *Lymnæus auricularius* was there also in great force, appearing upon the Cotteswolds to take the place of *L. pereger* in similar situations in the vale.

"Proceeding to South Cerney, Mr. Pooley called the attention of the party to the Church Steeple, which had been recently damaged by lightning, so much as, in the opinion of the incumbent, to render it unsafe for the performance of the usual services, and he is now in consequence seeking funds for its due restoration. It appears that the electric fluid first put to flight the weathercock from his proud position; so alarmed old Time in the personality of the clock that it retreated about four inches downwards; displaced

* Substituted for *flowery*.

most of the boarding of the clock-case, dislocated about twenty feet of the upper portion of the spire, finally passing out of a Norman window in the basement of the tower, driving out the glass and decently interring itself in the churchyard, first enlivening possibly some of the long smouldering ashes with 'unwonted fires.' The double arches which support the tower are interesting examples of the transitional style from the Norman to Early English, the shafts of the columns being lighter than usual in proportion to the mass supported, nearer together at the base than at the mouldings of their capitals, as at Elkstone, and the arches lanceolate though ornamented with patterns of the most distinctive Norman character. Over the doorway, also Norman, which so much resembles the south entrance of Quennington church as to suggest the probability of both being the work of the same mason, is an artistic version of the same legend which forms the subject sculptured in the tympanum of the north entrance arch at the last named place, exemplifying the power of the patron saint of the church to deliver souls from the evil one, combined with the representation of the Trinity, &c. occupying a similar position in the south doorway. The symbolical forms adopted in both cases so entirely correspond as to warrant the conclusion above indicated.

"Returning through Siddington the section was met by Mr. D. Bowly, who 'prevailed on it to stop,' not a la Turpin, but by the very acceptable offer of some lunch. The curious Norman font here is a prize for those who study such special features of ecclesiology, but the attention of all appeared to be for a while concentrated upon the newest in the ancient church—the window in stained glass to the memory of its late rector, and our late associate, the Rev. Henry John Bolland. The subjects treated are illustrative of the life of St. Peter, to whom the church is dedicated.

"The memorial windows of the Langley family, which was long settled here, and of which Geoffrey was seneschall to Edward the First, have been removed to Cirencester. The brasses which were once inserted above the canopied altar tombs in their chantry have met with even a worse fate than the glass, having long since, doubtless by the cupidity of some ignorant curator, been consigned to the common limbo of old metals, though their outlines are still sufficiently well preserved to convey to the instructed eye their form and character.

"Portions of inscriptions still remain in the heads of the windows, though in so mutilated a state as to be unintelligible; monograms, also, of the family are upon the walls and the spandrels of one of the arches dividing the chantry from the nave, but our only information respecting its rank and status is to be derived from the almost obsolete art of the herald, whose hieroglyphical contributions to the history of an ancient race are still perfect, except that whitewash has eclipsed all the once varied tints of

blazonry. The principal quarterings are those of Acton of Iron Acton, and Tame of Fairford. Members of this family were sheriffs of Gloucestershire in 1294, 1308, and 1477, and Huntly of Boxwell is its present representative in this county. It may be remarked here that the arms given by Fuller, in his list of sheriffs belong to a very distinct family, long settled in his time at Bristol, and, as appears from the Visitation of 1621, in the Huntley pedigree should be corrected as follows: *Arg. a fess sable in chief three pellets.*

"Here the section subdivided, the majority going on to the quarries at Furzen Leaze, in search of "tracks" on the Forest marble slabs, which were found in abundance: the minority to Preston church, to sketch the campanile for three bells, of elegant proportions and arrangement, so unusual as to be almost unique.

"All arrived at the College in time for dinner, from which period their proceedings were precisely identified with those of the general meeting."

In the evening, papers were read by Mr. Brodie, "On the Lias of Barrow-on-Sour, and the Inferior Oolite and Lias of Northamptonshire and Gloucestershire." Mr. Lycett also read a paper, "On the Inferior Lias and Oolite of the Cotteswold Hills, compared with similar deposits on the coast of Yorkshire."

On August 25th a very small party, consisting of the President, the Rev. S. Lysons, and Mr. J. Jones, with Mr. — Lysons as a visitor, met at Beckford Inn to breakfast.

As Dumbleton hill has become, through the labours of Buckman and Strickland, classic ground to the Jurassic geologist, a great increase in number was only waited for by the next train, but to no purpose. The time, however, was not ill spent in an inspection of the Church and Beckford Hall.

The former presents many features of Norman architecture in a good state of preservation, which would lead us to place the date of its foundation in the reign of Stephen, the ornamentation and the legendary subjects represented in the tympanum of the doorway arches being precisely those described at Quennington, but more coarsely executed.

Beckford Hall is a seat of a branch of the Worcestershire Wakemans, long settled here, of which the last Abbot of Tewkesbury was a member. It is interesting from the fact that it does not appear to have been improved or added to since the period of its erection. In the cellars are some arches which probably formed part of a Priory founded here in the Saxon times, of which the revenues were estimated in the taxation of Pope Nicholas at £32. 16s.; and in the garden is a fine avenue of box trees. The thanks of the Club are due to Mr. Woodward, who now resides here, for his kindness, in anticipation of its visit, in providing vehicles to convey its members to Dumbleton.

At the base of Dumbleton hill, apparently turned up in the

course of draining operations, were found fragments of a white band of lias claystone, full of a small trochiform looking univalve, apparently unnamed.

On the summit of the hill was obtained a fine series of characteristic Marlstone and Upper Lias fossils, already enumerated by Buckman and Strickland.

The day was one of excessive heat, and never was proffered refreshment more willingly accepted than that at the residence of Edward Holland, Esq.

A brief visit was paid to the Church, in consequence of a wonderful account of the antiquity of the bells, upon which were said to be inscriptions in characters so ancient and difficult as to have perplexed all the literati of the vicinity. As the honour of the Club was somewhat at stake, an attempt at the solution of the mystery was hazarded, and *one* bell which was pointed out as a test was examined. It bore the well-known name of Rudhall, of Gloucester, with the date of 1729, and the following inscription:—

"I to the church the living call,
And to the grave do summon all."

How often do difficulties of much more serious import to us vanish upon being boldly confronted!

Messrs. Woodward, of Bredon, with Mr. Woodward of Beckford Hall, joined the Club at dinner at Beckford Inn.

On September 15th, the Club met, after various alterations of the fixture, at the Tetbury Road Station, whence they proceeded to Sapperton tunnel, pausing for a while to examine and speculate on the interesting fault at Hailey Wood. At this point I particularly regret my own absence from the party, inasmuch as the origin of various faults (at least in the human race) has of late years formed the staple of my studies; and among so many learned men discussing the origin of one "very interesting fault," who knows what valuable lights might have been thrown on my own studies? As far, however, as the Chronicles of Buckman inform me, no suggestion was made as to that point of principal utility in searching into faults, viz. the best mode of amending them; he tells me that even the faults of the geologist are interesting.

And here, my friends, while we end our account of the summer gatherings of last year, I have unintentionally given an instance of the mode in which a mind is always apt to return, in season or out of season, to the subject which usually engrosses it. Shall I cry *peccavi*, and promise not to offend in a like manner again; or shall I brazen it out, and maintain that I was right and my remarks not alien to our Club? I'll take the latter line. I regret to say that but few days ago, a member of our Club intimated to me that he thought that an antiquarian subject, (he did not mean himself, for he is comparatively a young member,) was foreign to

the pursuits of a Club of *Naturalists*. Gentlemen, I stood aghast. I did not think that there had been one of our members so ignorant of the principles of a *Naturalist's* Club as not to recognize the fact that even all art is only founded on nature—that nature must be the base of operations in art—and that, therefore, the studies of a naturalist comprehend all possible studies.

On this view, forgive me if I touch for a few minutes on those studies which have of late called my attention from the pursuits which more commonly bear the name of nature, but which I find so cognate that I constantly trace how the thoughts on the one subject have fitted me for action on the other.

You, gentlemen, know the work on which I have been engaged, and which I have closely watched for some years. I will not attempt to give you an account of the spread of Reformatory Schools throughout England, (still less of their immediately expected rise in Ireland, Scotland, and Jamaica,) but I will simply state, as a matter, hard indeed to be believed without examination, but of which the hope appears more strong the closer we search into it, that—so fast and so surely is Juvenile Crime decreasing, in all places where the Reformatory System, as it is usually called, has a fair trial, I have great hope and trust that by Christmas, 1859, all, even the large cities of England, with the exception only of London, will be cleared of all *regular habitual premeditating* thieves under sixteen years of age; and if this be the case, I have no doubt that three years more will clear London. I grant that this appears so wild a hope as to be classed with impossibilities. What of that? Is it more *impossible* than the electric telegraph was twenty years ago? or than railroads were thirty-five years since?

No, my friends—when we have *completed our studies*, when we have worked out all the laws of nature, and can put definite bounds to them all—then may we be justified in saying that a thing is impossible—but, at present, so far is this from being the case, that the greatest glory and charm of our studies of nature consist in the fact that, deeply as we may search, and far as we may see, any increase of our knowledge only enables us to see more clearly the existence of farther fields beyond us, and thus proves the eternal truth of our studies, by shewing that they are blended with the Infinite.

Notes on Bisley Cross; also a Communication on Friar Bacon.

By CHARLES POOLEY.

As no record has been preserved of the ancient crosses that are so numerous scattered over this county, it seems desirable that this department of the Archæology of Gloucestershire should not be left entirely unrepresented. Having had my attention called to the subject, I shall be happy to supply this deficiency by occasionally contributing papers to the Transactions of the Club, which shall embody as much information respecting them as I have been able to accumulate; at the same time I may state that, in many instances, the paucity of materials at my disposal will oblige me to be content with a bare enumeration of the measurements of these monuments, and probable dates of their erection. This is the more to be regretted because an interest attaches to these crosses that enhances their value in the eyes of antiquarians. Many of them are the standing witnesses of events which at the period of their occurrence exercised a powerful influence over the destiny of this country; while others, as in the case of the Cross of Amney Holy-Rood, illustrate in a remarkable manner the ancient custom and practice of ecclesiastical tenure.

The subject of the present paper is Bisley Cross, or, as it is sometimes spelt, Bislye, Biselie, and Bisleigh, which stands at the west end of Bisley churchyard, where it forms rather a striking object, and may be mistaken for a handsome sepulchral monument. Lysons has figured it as a cross of the 13th century. Why it should be called a cross, it is difficult to say, as an inspection must convince any one that the term is misapplied. The building consists of a circular basement, on which is erected an upright hollow hexagon, formed by six three-centred arches, supported on round columns with beaded capitals and square plinths. On this tier rises a hexagonal pyramid built on a corresponding number of smaller open arches, with very deep scalloped mouldings. A thick fillet runs half way up the pyramid at each angle and terminates by bevelling. The small Greek cross of modern date which surmounts the summit, I suspect has no business there, as it certainly is not in keeping with the rest of the building: its place was formerly occupied by an equally incongruous object, namely, the baptismal font which now stands in the church. The total elevation of the whole building, from the ground line to the apex, is about twelve feet six inches. In the absence of any definite information, we may conjecture that this is a specimen of a detached bell-tower or turret of the thirteenth century, but it is difficult to conceive on what grounds it claims to be called a cross. Not only is the style of architecture in nowise analogous to that seen in the remains of any of the early



From a Gal. type by Charles Folley

Copy by Don Kirk for The Commons

churchyard crosses of this county, but it does not possess even a single member in common with them to indicate that it ever was intended as such, or was erected for the purpose to which churchyard crosses were dedicated. There is a tradition amongst the common people, who have nick-named it the "bone-house," that it leads by a subterranean passage to the interior of the church. The existence of some sort of chamber, communicating with the interior of the building, has been partially confirmed by the assurance of an old man whom I met there, that some years ago he "went down," and at the bottom found a large number of bones, and an excavation like a tomb "which ran some distance under ground." Should this prove to be the case, it would illustrate in some degree the ground plan of this mysterious building, and would dispose of the idea that the structure was ever intended for a cross. Where the excavation led to, and what was its purport, are questions for future explorers to decide.

Mr. Ball says that a tradition exists that a person was drowned in a well in the churchyard, that the well was ordered to be closed, that persons were forbidden to be buried in the churchyard, and that this erection was built over the spot.

Friar Bacon.

As an appendage to this note, but unconnected with the subject, I beg leave to lay before the meeting a copy of a letter I have received from Mrs. Clutterbuck, of St. Mary's Mill, Chalford, in reply to my enquiries respecting the tradition, that her house was formerly tenanted by no less a personage than the famous Friar Bacon.

The statement is to be found in *Sir Robert Atkins's History of Gloucestershire*, wherein it is related that "Friar Bacon was born at Todgmore Bottom, about a mile from Bisley, and that he was educated at St. Mary's Chapel, now St. Bury Mill, on Stroud river; where a room at this day is called Friar Bacon's study." The historian then goes on to state that "he was a very learned person, and wrote eighty books, and for his skill in mathematics was reputed a conjuror in those ignorant times," &c. "He died A.D. 1284."

Now all authentic English historians agree that Friar Bacon was born at Ilchester, in Somersetshire, about A.D. 1214, and that he was educated at Oxford, where he took the vows of a Franciscan in a convent possessed by that order at Oxford, and that he was buried in the church of the Franciscans about A.D. 1292. Nevertheless it is remarkable, that the traditional evidence which Mrs. Clutterbuck has obligingly furnished me with, corresponds with the statement of Sir Robert Atkins, and therefore will be read with interest.

Mrs. Clutterbuck says, "The house formerly had sunk into the name of Saintbury, but it has gone by the original name of St. Mary's for more than forty years. The account handed down to her thirty years ago, was, that Friar Bacon's room was the one which she made the nursery, and that that room and the closet adjoining, said to be his cell, has always borne the name of Friar Bacon's study. She also perfectly remembers that she was told, there had been a flight of steps, which communicated with the top of the house, but which were taken down when the house was altered, where there is still remaining a walk on the leads with a stone balustrade, which tradition said was that he made use of as a place for his astronomical observations."

It may be remarked that Sir Robert Atkyns makes Friar Bacon's death to have taken place A.D. 1284, which corresponds to the date given by some foreign writers, but our historians place the event eight years later.

The above communication I deem sufficiently curious to be preserved in the archives of our Club.

C. P.

Notice of some rare Bats, from the neighbourhood of Gloucester and Cheltenham.

By W. V. GUISE, F.L.S., F.G.S.

I have the pleasure of bringing to your notice to-day three Bats, which are deserving of registration upon the records of our Society, not only inasmuch as they may serve for the commencement of a series illustrative of our local Cheiroptera, but because they are all of somewhat unusual occurrence, and one, *V. mystacinus*, is amongst the rarest of our indigenous species.

The three examples to which I allude are *Vespertilio nattereri* and *mystacinus*, and *Rhinolophus hipposideros*. For the first-named species I am indebted to Nathaniel Skelton, the well-known taxidermist, of Cheltenham, who procured it in the neighbourhood of that town; while I had myself the good fortune to obtain the two others at Elmore, about five miles from Gloucester. Of these *V. mystacinus* is by far the rarest; and as but little is known of its habits, the story of its capture may not be without interest. In the beginning of the last month (May), I had for some days observed a small bat to issue from between the fissures of some old masonry which surrounds a pool in my garden, at Elmore, and, in the full blaze of the mid-day sun, to hawk over the surface of the water, flitting backwards and forwards with all the restless activity of its race. After several ineffectual attempts at capturing the little animal, I at length succeeded in enclosing it in my insect-net. A careful comparison with the descriptions and plates in Professor Bell's work on the British Mammalia seemed to justify me in referring the bat to the rare *V. Daubentonii*, of which only four examples are recorded in the above-named work as having been met with in this country. Being desirous, however, of obtaining the opinion of some naturalist more competent to form a correct judgment upon the matter than myself, I availed myself of the opportunity presented by a meeting of the Linnean Society to submit my specimens to the inspection of Professor Bell himself, who returned them duly named and labelled, and accompanied by a note in which occurs the following passage:—"I have examined your bats with care, and feel confident I have rightly named them; they are not common. I was a little doubtful at first about *Mystacinus*, but I feel now almost certain that I am right in so naming the specimen—this is the rarest of them—but in so many respects it resembles *Daubentonii*, that, but for its smaller size, it might be mistaken for it."

Now, having regard to the advantage attaching to the identification of these bats by so eminent an authority as Professor Bell, and at the same time, keeping in view the object towards which it especially behoves us as local naturalists to direct our attention,

namely, the collecting and systematising facts in illustration of the Natural History of our own county, I propose to place these specimens in the hands of our able friend and Secretary Professor Buckman, for deposition in the Museum of the Royal Agricultural College, at Cirencester, where they may serve as a nucleus for the gradual accumulation of the entire series of *Cheiroptera* indigenous to the county of Gloucester.

ON

RHYNCHONELLA ACUTA

AND ITS

AFFINITIES.

BY JOHN JONES, ESQ., GLOUCESTER.

LONDON.

1860.

PRINTED AT THE "GEOLOGIST" OFFICE, 154, STRAND, W.C.

ON
RHYNCHONELLA ACUTA

AND ITS

AFFINITIES.

ONE of the most remarkable fossils assumed to be distinctive of a particular geological horizon, and which, from its very striking outline, most readily impresses itself upon the mind, is the *Rhynchonella acuta* of the Lias-marlstone, a Brachiopodous shell common at Stinchcombe, Churchdown, and other localities of this district, and well known elsewhere. Having paid considerable attention to the class to which it belongs, I have long abandoned the common practice of placing in the cabinet only those specimens which chance to accord with the forms figured and described as *typical*. Instead of doing this, I have selected, as good examples, those which manifestly have not been crushed or injured prior to their entombment and petrifaction; and these I have arranged in series illustrative of specific development.

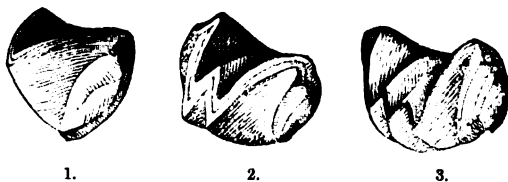
This mode of procedure has taught me that the species under consideration assumes forms varying from that under which it is most generally known; and it has led me to believe that several so-called species of various authors are, in reality, mere varieties of this.

All who have attentively studied the numerous Terebratulidæ of the Cotteswolds will have experienced the difficulty of assigning satisfactorily certain anomalous forms, occurring in beds ranging vertically from the Pisolite, or even lower, to the Cornbrash, to such well-established species as *Terebratula mazillata*, *T. perovalis*, *T. globata*, or *T. intermedia*, and will remember the remarkable varieties of individual character presented by other species, as, for example, *T. plicata*, *T. simplex*, *T. fimbria*, and *T. carinata*, sufficiently striking when studied in solitary examples, but, in an

extensive series, not suggestive of good and stable specific differences. The variability of character within recognized specific limits, then, being well known, I proceed to lay claim for *Rhynchonella acuta* to as great an amount of indulgence, in this respect, as for any of its congeners, referring in evidence to the specimens figured with this paper.

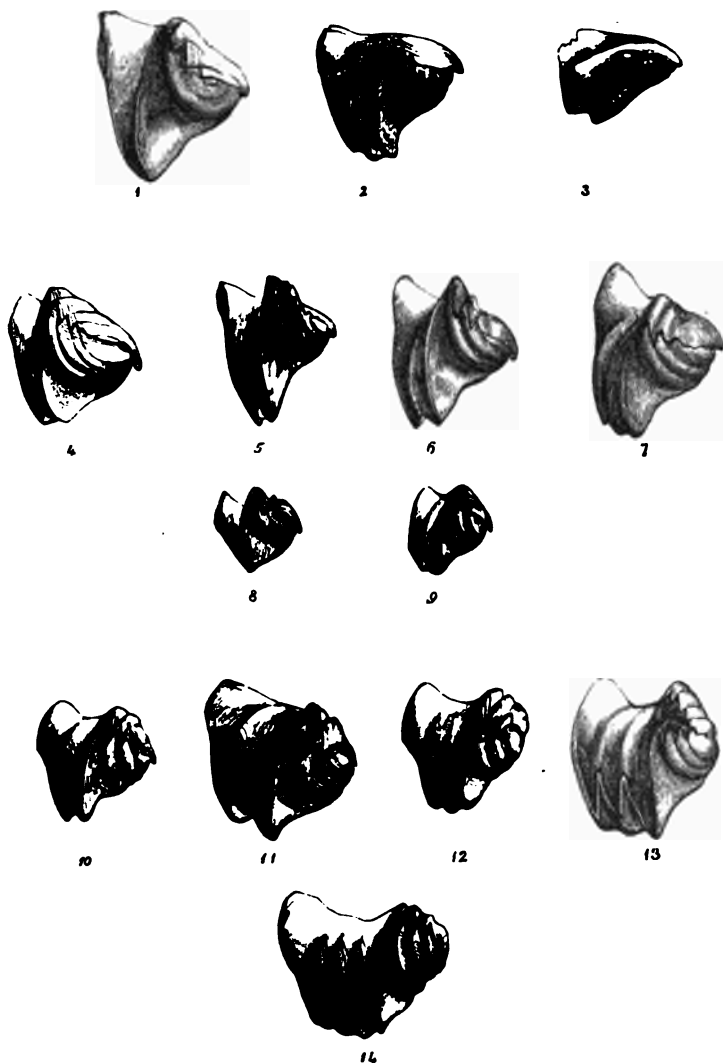
Its most common form is indubitably that figured by Sowerby and other authors, which occurs in the Lias-marlstone of Gloucester and Somerset, in the Lias-marlstone and ironstone-series of Yorkshire, in France, part of Germany, in the Macigno d'Aubange, the equivalent of those deposits in Belgium, &c.; but this I shall endeavour to show in the sequel to be an immature form, and that, in the succeeding stages, the species to which it belongs attains much larger dimensions, and a higher degree of development, than in the marlstone, although in that stratum it occasionally assumes characters of importance, as regards our present inquiries, which have not hitherto been formally noticed.

For example, it sometimes presents two mesial folds, as in Pl. I., Fig. 3, from Churchdown; and three mesial folds, as in Pl. I., Fig 2, from Stinchcombe. The scarcity of similar examples is, probably, not so much attributable to their rarity as to the intractable nature of the matrix in which they are imbedded, which renders the extraction of its most simple organic forms sufficiently difficult and laborious, and that of the more complicated still more so. A cursory examination will suffice to show that the examples referred to cannot be assigned to any other species than *R. acuta*, as they agree perfectly with the typical form in lateral outline, and differ from it in no other respect than in the number of mesial folds.



1. *Rhynchonella acuta*. 2. *Rhynchonella bidens*. 3. *Rhynchonella triplicata*.
(Copied from Plate XIII., Phillips' Geology of Yorkshire.)

On comparing these with the figures of *R. acuta*, *R. bidens*, and *R. triplicata*, of Phillips, from the marlstone and ironstone-series of



S. J. Mackie Del.

RHYNCHONELLÆ

In the Collection of J. Jones, Esq., of Gloucester.

Figs. 1-3. *Rhynchonella acuta*, from the Lias Marlstone.

Figs. 4-9. *Rhynchonella cynocephala*, from the "Cephalopoda-bed."

Figs. 10-14. *Rhynchonella cynocephala*, from the Upper Lias Sand.

Yorkshire, it appears to me that the author has merely represented more aged examples of the two varieties before us as species distinct from the first named.

Professor Morris, in the last edition of his "Catalogue of British Fossils," treats the difference of a plication, more or less, between *R. bidens* and *R. triplicata* as unimportant, although, instead of uniting these to *R. acuta*, and assigning to the three forms one specific name, he records them as synonyms of *R. variabilis*, one of the most widely-diffused brachiopods of the Lower Lias, and of which I doubt the occurrence in the marlstone of England at least.

In certain localities, as at Frocester, a young or dwarfed form of *R. tetrahedra* constitutes the principal bulk of large masses of marlstone, and has, I think, been mistaken for *R. variabilis*; but in neither of these species can I discover any features at all suggestive of affinity with that under consideration. That Professor Morris may be mistaken is not improbable, from the fact that the two most recent writers on the Jurassic formations of England and the continent, Oppel and Quenstedt, have both found themselves somewhat perplexed as to the true affinities of these forms, perhaps, to some extent, in consequence of having adopted, without due examination, his views. Oppel, in his observations on *R. variabilis* ("Juraformation," p. 187), after stating that it is found in the Middle as well as the Lower Lias, remarks, pertinently enough as regards the object of the present paper, that, "in Suabia it occurs particularly under the form of the biplicated variety (*R. bidens* of Phillips), which is found also at the base of the Middle Lias at Boll, Metzigen, Hinterweiler, and Balingen, with specimens possessing a greater number of folds (*R. variabilis* of Zieten, p. 42, f. 6, and *R. triplicata* of Phillips).

Bearing in mind the fact that *R. variabilis* of Zieten is not the typical form recognized by Schlotheim or Davidson, it is clear that Dr. Oppel considers the forms just described as belonging to one species, and, in his observations on *R. variabilis* of the Lower Lias (p. 121), he appears disposed to limit its stratigraphical range to the Lower Lias only, in which case, of course, they are not varieties of the latter.

Professor Quenstedt, in like manner, in his recently-published "Jura," treating of *R. bidens*, Phillips, seems disposed to consider it and *R. triplicata* as varieties of *R. acuta*, distinctly pointing out their

general resemblances ; although German authors generally agree in stating that this species does not occur in the Suabian Alps.

Not to needlessly multiply quotations, I may yet briefly state that Davidson, in his Monograph on British Jurassic Brachiopoda, figures what he considers to be the *R. bidens* and *R. triplicata* of Phillips as varieties of *R. variabilis*, which he believes to range through the Lower and Middle Lias;* but, unless his figures are taken from the original specimens of Professor Phillips (and these were very ill drawn by the last-named gentleman), I discover nothing in his observations upon either species to modify the conclusions at which I have arrived from a comparison of the observations of all these authors.

Labyrinthine as appears to be the confusion of ideas in the statements cited, the clue appears to me to lie within grasp. Let us remember that the three forms, in one case, occupy the same zone, occasionally occurring together, at other stages or places one or other numerically preponderating ; that the difference between *R. acuta* and *R. bidens*, in the opinions of authors and observers in every way entitled to respect, is no greater than between the latter and *R. triplicata*, being one of degree only and not of kind. The suggestion, therefore, naturally arises that they may really pertain to one species. Assuming that we are justified in arriving at this conclusion, all difficulties vanish. We simply learn the not uninteresting facts in its natural history—that the geographical distribution of one of the most characteristic shells of the stage to which it belongs was co-extensive with that of many of its usual companions, from which it would otherwise appear to be somewhat unaccountably separated ; and that, in particular portions of the area which it occupied, it attained to degrees of development denied to it in others.

Having pointed out instances of the confusion of these varieties with species of lower stratigraphical range, I will now direct attention to one instance of *R. bidens* having been recorded as occurring in a bed higher than that in which it is usually looked for.

In Phillips' "Geology of Yorkshire," this marlstone shell, there first figured and described, is stated, at page 157, in the list of organic remains of the Inferior Oolite, to have been found by Mr.

* In this monograph, Mr. Davidson gives his reasons from considering *R. bidens* and its synonym *R. triplicata*, as specifically different from *R. acuta*. His statements on this subject should be referred to.

Ripley in the Dogger, at Glaizedale. I have little doubt that, had Mr. Ripley's specimens been submitted to Cotteswoldian geologists, they would have been named *R. cynocephala*, and the close resemblance of certain forms of this shell to the former, which induced a practised observer to consider both specifically identical, suggests the expediency of inquiring whether they may not really be so.

Mr. Lycett finds *R. cynocephala* in the marly beds lying at the base of the sands which, in this district, usually rest upon the upper Lias, as at Nailsworth and elsewhere, although it has long been considered peculiar to the "Cephalopoda-bed" above those sands. It abounds at the Horsepools, Haresfield, and Frocester, where it presents three similar degrees of variety, attained to by those *R. acuta* in the marlstone. From the thin ferruginous earthy band dividing, at Haresfield, the "Cephalopoda-bed," into two portions, they are most readily extracted; the specimens are all more or less stunted in growth as compared with those from above or below; and there principally I have found the acute variety. The only recognizable feature of distinction between this and *R. acuta* is, that in the former the apex is not so much elevated, and is formed by a less acute angle than in the latter, approximating more nearly to its younger forms; although this difference of outline may partly be accounted for, by the fact that the marlstone, in the one case, only affords us casts, through the intractable nature of the matrix, while in the other the shells are exceedingly well preserved, exhibiting clearly lines of growth and perfect details of the states of maturity at which they had arrived.

With so great a constancy of form to a limited set of specific types as to perplex us, and to render essential the considerations of stratigraphical position in separating them, and with these derived from beds almost immediately following each other, it is not clear that valid grounds exist for their separation. All these forms indisputably have the same vertical range; they differ in no greater degree from each other than do the varieties of other universally acknowledged species. They appear and disappear simultaneously in strata of which they are everywhere some of the most remarkable fossils, and in which they are not associated with others that resemble them so much as to justify the confusion of nomenclature which has hitherto prevailed with regard to them. Why, then, should we make four, if

not five, species of that which is one only? It is not pretended by naturalists that the difference of a fold or two in shells of this genus marks more than a difference of age or of development; hence, assuming the foregone conclusions to be correct, I venture to state that neither of the forms noticed by the authorities cited, represents the full and perfectly developed condition of this species.

In a certain portion of the usually unfossiliferous sands near Painswick, intermediate to those beds in which *R. acuta* first becomes known to us and those in which *R. cynocephala* disappears, specimens occur with the latter, by no means rare, which, on the principles I have endeavoured to elucidate, must be referred to the same species. These specimens not only attain to a much greater size, but assume three or four mesial folds as their most common number. I have not found them elsewhere, nor have I seen them in any other collection than my own; but this happens probably from their having been considered unworthy of retention, on account of the imperfect state in which they are usually found.

I would remark, in conclusion, as lending additional force to my observations, that Mr. Hull considers the *Terebratula* which occurs so abundantly in the Frocester and Haresfield beds* with *R. cynocephala* to be identical—and Mr. Davidson has, I believe, adopted this view—with *T. punctata*, a shell which occurs in the marlstone associated with *R. acuta*; we cannot, therefore, be surprized, from their manifest community of habit, that these two species should have gone through time together, from the period of their first creation to that of their final extinction.

I trust that these observations on the natural history of an extinct Brachiopod may not have seemed tedious: but I believe every true geologist will appreciate any endeavours to clear up errors or confusion, however small, with regard to any of his "time and tide" marks; while the possible demonstration of the wide divergence of varieties from their assumed types, as exemplified in this ancient species under varied conditions of existence, may not be devoid of interest to the physiologist in his investigation of phenomena of a similar nature.

* *R. rimosa* and *R. furcellata*, also middle Lias shells, have been found in these beds by Dr. Wright, of Cheltenham, and myself.

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